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Articles

THE DISTRIBUTION OF AGRICULTURAL LAND IN AUSTRALIA

B. R. DAVIDSON

Agricultural land can be defined as any land from which crops can be produced and on which livestock can be sustained. Physically any area in the world is capable of producing any crop and of maintaining any type of livestock. An artificial environment can always be created. Moisture, light, temperature, soil structure, and nutrient elements can always be adjusted to suit the needs of any plant or animal, but the greater the change that has to be made in the natural environment the higher the cost of producing the commodity concerned. Agricultural land should be classified according to its ability to produce, with the minimum adjustment to the natural environment.

In Australia moisture and topography are the chief factors limiting plant production. Temperature and light place less limitation on adequate growth although Trumble (1937) and Slatyer (1960) have pointed out that pasture growth is retarded in winter in southern Australia. Soils and the original vegetation frequently increase the cost of developing land, but these two features of the natural environment are the easiest and cheapest to change. Any classification of potential arable land in Australia should be based on the availability of moisture, with adjustments for land which is too steep or stony for intensive agricultural development.

Classification of Agricultural Land

Prescott and Thomas (1948-49) have established the boundaries of areas in Australia with growing seasons of different lengths by measuring the relationship between precipitation and evaporation. Prescott considered that any region where the

$$\frac{\text{Precipitation}}{\text{Saturation Deficit}^{0.75}} \quad (P/SD^{0.75})$$

exceeded the value of 4 for five months of the year was capable of agricultural development. Areas where this ratio exceeded 4 for more than nine months of the year were thought to be capable of intensive development, as the dry season was unimportant. Prescott also considered that, while a $P/SD^{0.75}$ ratio exceeding 4 meant that sufficient moisture was available for the initiation of growth, a period during which this ratio exceeded the value of 8 was necessary for reasonable crop development and the longer the period during which the ratio exceeded 8 the higher the crop potential. Most crops require a growing season which includes a period when $P/SD^{0.75}$ exceeds 12 if the normal transpiration requirements for high yields are to be met.

In some respects the adoption of a system of moisture zones based on Prescott's formula is an extremely lenient one, as in many parts of tropical and subtropical Australia $P/SD^{0.75}$ is never greater than 12 for any month. At the same time the formula does not allow for moisture storage. These two faults cancel each

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TABLE 1

The area and distribution of different moisture zones in tropical and temperate Australia.

Length of growing season	More than 9 months				5 to 9 months			Total of all moisture zones
Number of months with $P/SD^{0.75} > 8$	> 8	4-8	< 4	< 4*	4-8	< 4	< 4*	
Tropical Australia (State)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)
Northern Territory	—	—	—	—	36,526	—	—	36,526
Queensland	—	2,810	—	—	32,186	8,556	29,502	73,054
Western Australia	—	—	—	—	2,810	—	—	2,810
TOTAL	—	2,810	—	—	71,522	8,556	29,502	112,390
Temperate Australia (State)								
Queensland	2,810	15,453	5,619	11,239	—	2,810	46,361	84,292
Western Australia	—	4,215	—	—	37,932	12,644	—	54,791
New South Wales	32,780	31,219	7,805	—	14,026	28,097	—	113,927
Victoria	18,263	11,239	—	—	16,858	7,024	—	53,384
South Australia	—	351	—	—	11,239	12,644	—	24,234
Tasmania	14,049	2,810	—	—	—	—	—	16,859
TOTAL	67,902	65,287	13,424	11,239	80,055	63,219	46,361	347,487
ALL AUSTRALIA	67,902	68,097	13,424	11,239	151,577	71,775	75,863	459,877

*Zones with a discontinuous growing season.

other in southern Australia, where winter storage is important, but not in subtropical or tropical Australia. On the other hand the higher temperatures experienced during the growing season in tropical and subtropical Australia probably allow crops to mature in a much shorter period than in southern Australia. It is possible that a growing period of four months in the tropics is as useful as one of five months in southern Australia.

By defining the boundaries of the areas in which the ratio of P/SD $^{0.75}$ exceeds 8 for four and eight months respectively and by superimposing this measure of moisture supply on the areas of five to nine, and greater than nine months growing season, the area of five to nine months growing season is split into wet and dry zones and the greater than nine months area into dry, medium, and wet zones. In some parts of northern Australia the growing season is broken by a period of drought in the autumn of up to two months, reducing its agricultural potential. When these areas with a growing season broken by a drought are included, seven zones with different moisture characteristics are established. The area of each moisture zone, as established by planimeter measurement from Prescott's map is stated in Table 1 and the definition and distribution of the zones are shown in Figure 1. In using zones of moisture availability as defined by Prescott, rainfall variability is completely ignored. The moisture zones with a growing period of more than five months in the southern states have a rainfall variability from the mean annual rainfall of less than 20 per cent. In the northern states only the Katherine-Darwin area in the Northern Territory has a variability of less than 20 per cent, both tropical and temperate Queensland have a variability ranging from 20 to 30 per cent (Leeper 1960). The zones also ignore the possibility of extending the arable area in Australia by means of irrigation or water harvesting.

Land-use Pattern

The effectiveness of these moisture zones in defining the agricultural use of land in southern Australia can be gauged by comparing Figure 1 with the land-use pattern shown in Figure

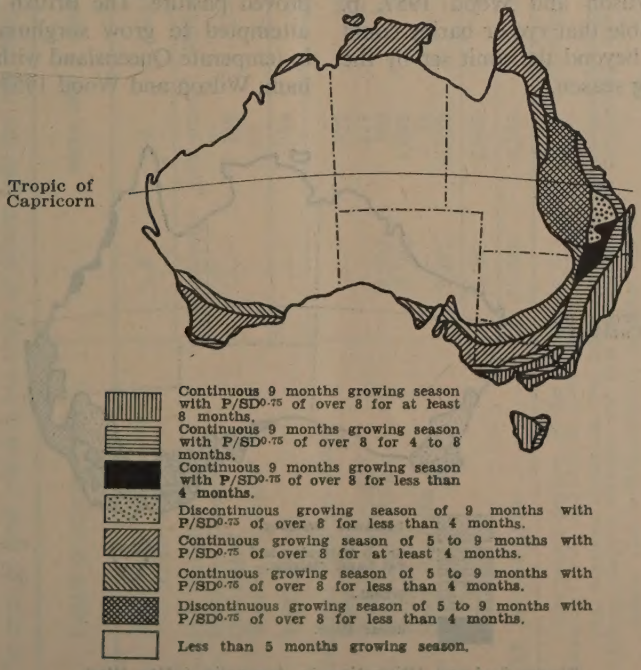
Tropic of Capricorn
Continuous 9 months growing season with P/SD0.75 of over 8 for at least 8 months.
Continuous 9 months growing season with P/SD0.75 of over 8 for 4 to 8 months.
Continuous 9 months growing season with P/SD0.75 of over 8 for less than 4 months.
Discontinuous growing season of 9 months with P/SD0.75 of over 8 for less than 4 months.
Continuous growing season of 5 to 9 months with P/SD0.75 of over 8 for at least 4 months.
Continuous growing season of 5 to 9 months with P/SD0.75 of over 8 for less than 4 months.
Discontinuous growing season of 5 to 9 months with P/SD0.75 of over 8 for less than 4 months.
Less than 5 months growing season.

Figure 1—Moisture zones of Australia.

2. Intensive dairying and fruit growing, except where these practices are supported by irrigation, are limited to areas with a growing season of more than nine months and where P/SD $^{0.75}$ exceeds 8 for at least eight months. The greater part of the sheep-fattening and fat-lamb zone of southern Australia is within the two zones with a growing period of five to nine months with P/SD $^{0.75}$ exceeding 8 for at least four months, or in zones with a nine months growing period with P/SD $^{0.75}$ exceeding 8 for less than four months (Wadham, Wilson, and Wood 1957, p. 86). Practically the whole of the wheat belt is located in the zones with a five to nine month growing season and wheat yields are generally higher in the wetter of these zones. In northern New South Wales and southern Queensland the zones with a continuous five to nine months growing season cease to exist and wheat is grown in the drier of the zones with a growing season of more than nine months (Wadham, Wilson and Wood 1957, p. 156). In Western Australia and South Australia the wheat belt does extend beyond Prescott's limit of a five months growing season, but yields are extremely low and variable (Wadham, Wilson and Wood 1957, p. 142-147). It is possible that rye or barley could be grown in areas beyond the limit set by the five months growing season.

In tropical Australia it is more difficult to test the validity of these moisture zones as a guide to agricultural land use. In Queensland sugar cane and tropical fruits are limited to areas with a growing season of more than nine months and a P/SD $^{0.75}$ of 8 for more than four months. But this is the only area within the tropics where agriculture is practised. Experiments carried out by C.S.I.R.O. indicate that peanuts, sorghum, and Townsville lucerne can be grown at Katherine, N.T. which is within the area with a five to nine months growing season (Division of Land Research and Regional Survey 1959). These crops have also been grown, on the Ord River which has a growing season of less than five months (Kimberley Research Station Progress report 1958). Christian (1959) considered that the 25 inch isohyet fixed the possible limit of crop production in northern Australia and this includes large areas of land which are excluded by Prescott's limit of a growing season of at least five months. It is doubtful if the land with a growing season of from five to nine months broken by a brought of at least two months is capable of supporting crops or improved pasture. The British Food Corporation attempted to grow sorghum within this zone in temperate Queensland without success (Wadham, Wilson and Wood 1957, p. 245), although

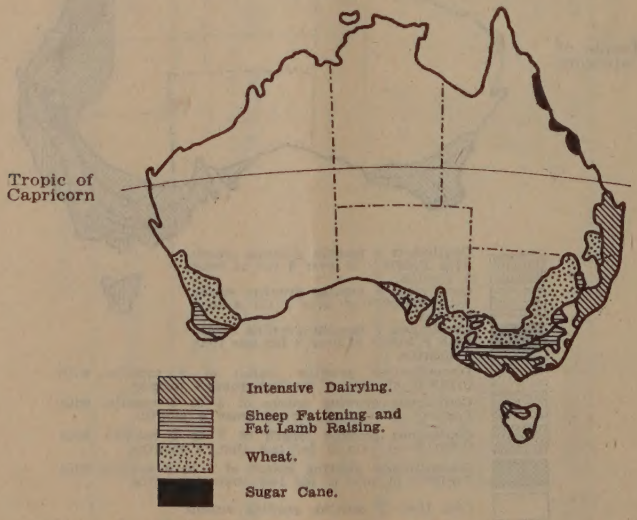

Figure 2—Land Utilization in Australia (after Wadham, Wilson and Wood, 1957).

TABLE 2

The area of land which is too steep or where soils are too stony for agricultural development in different moisture zones in Australia.

Length of growing season	More than 9 months				5 to 9 months			Total in all moisture zones
Number of months with $P/SD^{0.75} > 8$	> 8	4-8	< 4	< 4‡	4-8	< 4	< 4‡	
Tropical Australia (State)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)
Northern Territory	—	—	—	—	18,662	—	—	18,662
Queensland	—	739	—	—	13,142	5,915	—	19,796
Western Australia*	—	—	—	—	2,810*	—	—	2,810
TOTAL	—	739	—	—	34,614	5,915	—	41,268
Temperate Australia (State)								
Queensland	—	722	181	2,707	—	—	—	3,610
Western Australia†	—	211	—	—	1,897	632	—	2,740
New South Wales	4,500	500	—	—	—	—	—	5,000
Victoria	9,792	1,088	—	—	—	—	—	10,880
South Australia	—	51	—	—	458	509	—	1,018
Tasmania	7,451	1,030	—	—	—	—	—	8,481
TOTAL	21,743	3,602	181	2,707	2,355	1,141	—	31,729
ALL AUSTRALIA	21,743	4,341	181	2,707	36,969	7,056	—	72,997

* The small portion of the Kimberley area with a 5 to 9 months growing season is shown to be completely composed of skeletal soils by Prescott (1944) and this is confirmed by Speck et al. (1960).

† In Western Australia the land capable of agricultural development is made up of a dissected peneplain; about 5 per cent. of the original ironstone plateau remains and this is unsuitable for development and has been excluded.

‡ Zones with a discontinuous growing season.

N.B.: The above areas of land were obtained from the following sources — Northern Territory, Perry (1960); tropical Queensland, Prescott (1944); tropical Western Australia, Speck et al. (1960); temperate Queensland, Gentilli and Fairbridge (1951); Government Statistician of N.S.W. (1957); Victoria, Wadham, Wilson and Wood (1957); Tasmania, Lowndes and Maize (1937).

TABLE 3

The area and distribution of potentially arable land in different moisture zones and States in Tropical and Temperate Australia.

Length of growing season	More than 9 months				5 to 9 months		Total area in all moisture zones	Percentage of total area in each State
Number of months with P/SD $^{0.75}$ > 8	> 8	4-8	< 4	< 4*	4-8	< 4		
Tropical Australia (State)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	
Northern Territory	—	—	—	—	17,864	—	17,864	43
Queensland	—	2,071	—	—	19,044	2,641	23,756	57
Western Australia	—	—	—	—	—	—	—	—
TOTAL	—	2,071	—	—	36,908	2,641	41,620	100
Percentage of total	—	5	—	—	89	6	100	—
Temperate Australia (State)								
Queensland	2,810	14,731	5,438	8,532	—	2,810	34,321	13
Western Australia	—	4,004	—	—	36,035	12,012	52,051	19
New South Wales	28,280	30,719	7,805	—	14,026	28,097	108,927	40
Victoria	8,471	10,151	—	—	16,858	7,024	42,504	16
South Australia	—	300	—	—	10,781	12,135	23,216	9
Tasmania	6,598	1,780	—	—	—	—	8,378	3
TOTAL	46,159	61,685	13,243	8,532	77,700	62,078	269,397	100
Percentage of total	17	23	5	3	29	23	100	
ALL AUSTRALIA	46,159	63,756	13,243	8,532	114,608	64,719	311,017	
Percentage of total	15	20	4	3	37	21	100	

* Zone with a discontinuous growing season.

small areas of this crop are grown for stock feed.

Distribution of Moisture Zones

The area, and distribution among the different States, of the moisture zones as defined by Prescott in tropical and temperate Australia are shown in Table 1. Not all of this land is suitable for agricultural development as most of Australia's highlands are within the moister areas where topography, and in some cases skeletal soils in the mountains, make agricultural development extremely difficult. In tropical Australia there are extensive areas of skeletal soil, outside the highland areas. The area and distribution of mountainous and skeletal regions within each climatic zone can be obtained from various sources and these are listed in Table 2. By subtracting the mountainous and skeletal areas in Table 2 from the areas of each moisture zone in Table 1, the area and distribution of each moisture zone capable of agricultural development can be obtained and these are shown in Table 3. Land with a growing season of five to nine months broken by drought has also been excluded from this table because of its doubtful agricultural potential.

Areas for Development

Table 3 shows that the area of agricultural land which might be improved and used other than as sparse grazing land is 311 million acres, of which 42 million acres (14 per cent) is north of the tropic of Capricorn and 269 million (86 per cent) is in temperate Australia. Only 5 per cent of the land where agriculture might be practised in tropical Australia has a growing season of more than nine months, compared with 48 per cent in temperate Australia. Temperate Australia thus has a far greater area where development might be possible, and a far higher proportion of land with a long growing season which is capable of really intensive development.

The 311 million acres of potential arable land obtained in this estimation is 100 million acres less than that obtained by Davies (1952), because of the exclusion of 75 million acres with a discontinuous growing season in Queensland. The use of Prescott's five months growing season rather than the 30 inch isohyet in the Northern Territory and northern Western Australia excludes large areas of land which are included by Davies.

In northern Australia, land with a growing season capable of supporting crops is divided fairly equally between the Northern Territory and Queensland. South of Capricorn, New South Wales has almost twice as much land capable of development as any other state. Western Australia occupies second place but very little of this land has a growing season of more than nine months. The bulk of the land with a long growing season is in New South Wales, Victoria, and Tasmania.

It is also useful to estimate the area and distribution of land in temperate and tropical Australia which is not at present in intensive agricultural and pastoral use and to assess where development might be possible. It is impossible to make an exact estimate as the relevant statistics are not available, but an approximate estimate can be made by subtracting the area of land in all forms of land use from the total area where development might be possible. This calculation is carried out in Table 4. Care must be taken in defining land already in intensive agricultural or pastoral use. In temperate areas all leasehold and freehold land in agricultural holdings has been included, but land being used under grazing licence has been excluded as it is normally lightly stocked and not improved in any way. In tropical Australia only freehold land has been included as being in intensive use, as improvement of leasehold land in the tropics is normally limited to fencing and water points.

The use of such a definition underestimates the area of undeveloped land in temperate Australia as many of the leasehold areas, particularly in subtropical Queensland are no more developed than those north of the tropic. Thus the estimate of less than 5 million acres of undeveloped land with a growing period of more than five months in Queensland must be regarded as a minimum figure. As all freehold and leasehold land in temperate Australia already occupied for pastoral or agricultural purposes has been included in the estimate of land already utilized, the definition takes no account of undeveloped land in

TABLE 4

A comparison between the area of land already occupied and the area where agricultural development might be possible in Temperate and Tropical Australia.

1	2 Area where agricultural development might be possible	3* Area of land already in intensive pastoral or agricultural use	4† Area of inland waterways	5‡ Area of Towns	6§ Area of roads and railways	7 2−(3+4+5+6) Unoccupied land where development might be possible	8 3+7 Total area available for agriculture
Tropical Australia (State)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)	(000 acres)
Northern Territory	17,864	—	357	7	24	17,476	17,476
Queensland	23,756	3,576	48	56	92	19,984	23,560
TOTAL	41,620	3,576	405	63	116	37,460	41,036
Temperate Australia (State)							
Queensland	34,321	27,310	686	679	821	4,825	32,135
Western Australia	52,051	37,947	1,041	325	935	11,803	49,750
New South Wales	108,927	94,426	2,254	1,769	1,853	8,625	103,051
Victoria	42,504	32,078	850	1,321	1,691	6,564	38,642
South Australia	23,216	21,113	464	431	921	287	21,400
Tasmania	8,378	6,547	167	157	189	1,318	7,865
TOTAL	269,397	219,421	5,462	4,682	6,410	33,422	252,843
ALL AUSTRALIA	311,017	222,997	5,867	4,745	6,526	70,882	293,879

* Sources — Government Statistician of Queensland and Government Statistician of South Australia (Private communications); Government Statistician of N.S.W. (1957); Government Statistician of W.A. (1957); Government Statistician of Victoria (1954-58); Commonwealth Government Statistician (1957).

† Inland waterways are 2 per cent. of the agricultural area of N.S.W. and the same ratio was assumed for other States.

‡ In N.S.W. the area of towns and cities is equal to 1.93 acres per occupied dwelling. Town and city areas in other States were estimated from this figure (Government Statistician of N.S.W., 1957).

§ Roads occupy 16 acres per mile of road in Victoria and estimates for roads and railways in other States were made on this basis (Government Statistician of Victoria, 1954-58).

occupied holdings in temperate Australia, and many holdings even in intensively farmed, high rainfall regions have areas of land which could be developed. In some areas whole properties are uncleared. Conversely by defining all leased land north of the tropic as undeveloped, the definition exaggerates the area of undeveloped land in northern Australia.

A comparison between the areas of land already developed and those where agricultural development might be possible using the above definition is made in Table 4. In temperate Australia 219 million of the 252 million acres of agricultural land are already occupied. There are however, still 33 million acres of land where agricultural development might be possible in temperate Australia, an area which is only slightly less than the 37 million acres of land suitable for development north of the tropic.

Much of the 33 million acres of unoccupied land, on which agricultural development might be possible in temperate Australia is in the drier zones. This is particularly true of the 11 million acres in Western Australia and is also true of part of the 6 million acres in Victoria which are in unoccupied areas in the Mallee. Part of it is, however, eucalypt forest with a growing season of more than nine months, on the eastern and south-western coasts of the continent. It has been estimated that there are 2 million acres of unoccupied land suitable for agriculture in the coastal strip between Eden (N.S.W.) and Lakes Entrance (Vic.) (Davidson 1954) and there are probably larger areas of the same type of land on the eastern coast of Australia north of Eden, and in Western Australia.

With existing statistical information it is impossible to give the exact location of this land and its area and nature could only be established by field surveys. Undeveloped land north of the tropic is equally distributed between Queensland and the Northern Territory and it is practically all in moisture zones with a growing season of five to nine months.

It should be stressed that the land classification used is based purely on climate and topography. No account has been taken of soils, and the problems of utilizing much of the land under discussion have yet to be solved. In the southern areas of temperate Australia it is possible to establish improved pastures. Grass and legume species suitable for the northern half of the temperate zone and for tropical Australia, are now being tested and developed but are not yet in commercial use. It has still to be established that cereal crops could be grown in the wetter areas of temperate Australia.

Much of undeveloped land in the moister parts of temperate Australia is eucalypt forest which is used for timber. If this was brought into agricultural production the area of forest would be reduced. However, much of Australia's eucalypt forest could be replaced by conifers which have at least four times the yield of eucalypts. A partial replacement of eucalypts by conifers in the 31 million acres of rugged land in temperate Australia would give a far greater increase in timber production than any loss sustained by turning coastal eucalypt forest into agricultural land.

Conclusion

In spite of the inaccuracies which creep into calculations of this kind the following points are obvious.

(1) Australia has almost 300 million acres of land where intensive agricultural or pastoral development might be possible. Of this land 252 million acres (86 per cent) are south of the tropic of Capricorn and 41 million acres (14 per cent) are north of this line.

(2) Of the unoccupied land in Australia where agricultural development might be possible, 33 million acres are in temperate Australia and 37 million acres are in the tropics.

Thus the areas of this land north and south of the tropic of Capricorn in Australia are approximately equal.

Acknowledgments

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AGRICULTURAL ADJUSTMENT IN A CHANGING INSTITUTIONAL SETTING

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A number of changes are currently taking place in Australia's financial institutions and in the economic organisation of marketing which may well call for extensive adjustments in Australian agriculture. This article examines some of the problems which changing conditions pose in the fields of farm credit, agricultural extension, and marketing research. Farm credit is presented as one of the major unresolved problems of agricultural policy in Australia, with far-reaching implications for the future organisation of farming. A change in the philosophy of our agricultural extension services and the establishment of a federal agency charged with the task of undertaking an enlarged program of research into agricultural marketing problems are suggested as means of facilitating adjustments.

Problems of Capital Supply

Three major trends are currently affecting the ability of primary producers to undertake developmental programs on their properties:

(a) the greatly increased amounts of capital required for modern farming;

(b) the reduced ability of primary producers to finance developmental expenditure out of current income as a result of the cost-price squeeze being experienced by major rural industries;

(c) the withdrawal of the trading banks from the field of long and medium-term financing of developmental undertakings, and the increasing tendency for them to confine their operations to the provision of short-term working capital.

The first of these factors, the growth in capital requirements for an economically-viable farm, is not simply a reflection of rising general price levels, but stems from more fundamental changes in the conditions of agriculture. It is more or less inseparable from economic progress that larger amounts of capital will have to be employed in the farm business if the average earnings in agriculture are to remain comparable with those in urban occupations. Without a high rate of capital formation Australian agriculture will come to be characterised by low-income rural communities such as those existing in many parts of the United States, and typical of peasant populations of many other advanced industrial economies.

Traditionally farmers have financed the greater part of developmental expenditures from current incomes and funds on hand. Borrowed capital has been an important but secondary source of finance. With the growth in capital requirements, however, the customary processes of capital formation in agriculture are no longer necessarily adequate, and additional resort to borrowed funds may well be required.

The difficulties of developing a property out of current income have, of course, been greatly accentuated by the price-cost squeeze and the consequent decline in net farm incomes. This is illustrated by an analysis carried out recently by R. A. Pearse (unpublished data) at the University of New England.

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Pearse used linear programming to determine the best way of going about a farm development program, based on pasture improvement, on a holding of 1200 acres in the New England region of New South Wales. In this project he has compared the financial results of a large number of alternative programs, using different methods of pasture establishment including prepared seed bed, combining, broadcasting and aerial top-dressing techniques, given varying amounts of capital available. The findings of the study are very relevant to a discussion of farm credit policy.

Assuming a wool price of 60d. per lb clear of freight and marketing expenses, an operator who has only an average of £500 per annum to invest (plus 50 per cent of additional income obtained) would, at the end of a 10-year period, have less than half of his property improved (actually 477 acres out of 1200), and would derive a total net income per acre of only £13.6 during the first 15 years. On the other hand an operator, who could borrow £5,700 and plough back all additional revenue, could improve the whole of the property in 10 years with an aggregate net income per acre of £25 over the 15-year period. Access to £10,000 borrowed capital would raise the 15-year net income per acre to £34. If the wool price were only 48d. per lb net, he would still be able with a loan of £10,000 to improve all but 87 acres of the property within 10 years and earn a 15-year net income per acre of £24.

Two important conclusions may be summarized:

(a) The best program to adopt (varying in the area improved, the method of establishing improved pastures, and the timing of developmental work in the 15-year period) depends very clearly upon the amount of capital available and the particular repayment commitments for borrowed moneys where these are involved.

(b) If a farmer does not have access or resort to borrowed capital and has to finance development entirely out of income, he will not only take an inordinately long time to bring his property to a fully-improved condition, but the income-earning capacity of the property at the 100 per cent improved-pasture level may well be lower (because his optimum program will involve the choice of establishment methods of lower ultimate income-earning capacity).

The inability of primary producers to progress by lifting themselves up by their bootstraps and the striking contribution which wisely-deployed borrowed capital can make to farm productivity are also illustrated by the two case studies of grazing properties made in the Armidale and Quirindi districts of N.S.W. by Waring and Muir (1961).

Changing Role of Banks

A change in the role of the trading banks has been indicated recently by spokesmen for the banks. The banks now regard their function as the provision of short-term working capital, with the provision of longer-term finance for development envisaged as a task for institutions outside the banking system. Merry (1959) states that:

> "the post-war period has also seen marked changes in the type of business undertaken by the trading banks. The Central Bank, in its co-ordination of the banking system, has concentrated consistently on the necessity for the trading banks to limit their activities, as far as reasonably possible, to the provision of working capital, leaving market sources to provide funds for fixed capital purposes. Perhaps the only exception for this more or less uniform rule applied by the authorities, has been realization of the particular needs of housing in the past decade of rapid population growth."

The average duration of advances made by one leading bank is now about four to five years, compared to an average of eight to nine years before the war. From the bank's point of view, this shift towards short-term lending is part of a rational adjustment to make better overall use of its financial resources in conditions of chronic pressure upon capital supplies in a rapidly-expanding economy. However, it leaves a major hiatus in credit facilities for rural development and property purchase. If, because of their new preference for short-term loans, the banks are no longer to provide adequate credit of the kind required by farmers, then there is clearly a need for some new institutions to replace the banks in their

traditional role. This need is all the greater in view of the growing amounts of capital required for modern farming practice.

Industry, which like agriculture relied heavily upon bank credit before the war, has found other methods of obtaining developmental capital including such means as unsecured notes and deposits. However, the organisation of agriculture along family-farm lines itself limits farmers' access to such alternative sources of capital. It would seem only fair that if the central bank policy is to encourage a withdrawal by the trading banks from their former role as providers of medium-term and long-term capital for agriculture, and if the capital market outside the banking system is quite unsuited to the existing organisation of agriculture, then some action to provide alternative institutions for the purpose should be undertaken.

This involves, but by no means begs, the question whether preservation of the existing predominantly family-farm organisation of agriculture is to be an important objective of policy. Some observers point out that there is nothing sacrosanct about a particular form of farming organisation and suggest that if the family-farm (in which the management, a good deal of the labour, and most of the capital requirements, are provided by the farm operator) cannot survive under conditions of growing capital requirements for an economic unit and a more limited role on the part of traditional lending institutions, then we should not regret its passing.

In some overseas countries, particularly in North America, the growth of capital requirements beyond the amount which individual farmers can provide from their own resources has already led to far-reaching changes in the organisation of some agricultural industries. Feed merchants and processing firms have extended their operations to the control of farms in the broiler-chicken and pig-meat industries. This process of vertical integration is sometimes achieved by a system of contracts; at other times by the assumption of full ownership and control of the farm by the integrating firm. In return for the capital to carry on production under the larger scale operations necessitated by modern technology and for the reduction of price uncertainty and guidance in technical problems often provided, many farmers have relinquished a large measure of control over production decisions, and, in some cases, have accepted modified tenure rights very little different from those of a hired labourer.

The spread of this new form of business organisation in farming has given rise to misgivings that it may turn back the clock towards a new serfdom of farmers. Breimyer (1959) expresses the fear that after a long historical trend towards greater freedom of individual landholders, represented for example in the disintegration of the feudal system, there may now be a movement in the reverse direction towards a new form of organisation resulting in an agriculture controlled by interests outside farming.

Such a trend, or at least the replacement of the family farm by some form of corporative enterprise, is an alternative to the development of new credit institutions more closely tailored to the new situation. A third possible outcome, viz., a sustained downward drift in agricultural incomes relative to those in urban occupations, could not be regarded as a solution. In the long run either rural credit facilities will be improved, preserving our traditional family-farm organisation of agriculture in the face of greatly-increased capital requirements, or, some other organisation will tend to emerge in which the farm family is likely to have less independence and considerably less control of management decisions. I do not argue for or against either of these alternatives; I merely want to stress that a choice between them is implicit in any decision on government policy for rural credit. If the choice were mine, however, I would want to be convinced, before opting for corporative farming or a take-over by agricultural-business firms, that the new organisation going to take shape would be more efficient than the family farm unfettered by capital rationing.

The Development Bank

The Commonwealth Development Bank, established early in 1960, falls far short of the requirements for a new farm credit institution

to compensate for the withdrawal of the trading banks from the function of providing intermediate-term and longer-term capital. Although its objectives and lending principles are admirable, its scale of operations and its lending resources are altogether too limited for it to make any major contribution to a solution of the problem.

The Development Bank's loans incorporate the following features:

(i) projects considered suitable for lending must have clear-cut developmental features;

(ii) provision is made for progressive loans for carrying through a program;

(iii) emphasis in loan appraisal placed on prospects for success of enterprise rather than on collateral security, subject, however, to certain requirements of minimum equity of the farm operator in the investment.

(iv) some provision for flexibility of repayment provisions including deferred commencement of repayment instalments;

(v) the maximum loan provision has apparently been increased considerably from that of the Mortgage Bank;

(vi) the interest rate is not concessional and hence does not encourage wasteful use of the nation's limited investable funds in low-yielding projects;

(vii) the provision that loans are made only in cases where credit is not available from normal commercial sources provides an adequate safeguard for private enterprise banking institutions;

(viii) the provision of technical and economic advisory services to the borrower is in accordance with the modern practice of "supervised" credit in both special government credit agencies and many private banks in the United States.

It is difficult to suggest improvement upon these principles. However, the Development Bank's resources for lending to primary producers, apart from hire purchase on tractors and agricultural machinery, have not been increased very greatly above those of its predecessor, the Mortgage Bank. Its capital has been augmented by only £10 million and, even if all of this were employed in lending for rural development (most unlikely in view of its other functions), it would probably provide only a total of some £15 million for the rural industries. When it is considered that the farm debt in Australia, excluding amounts owing under private mortgages, hire purchase agreements, and credit arrangements of merchants and stores, amounted to £468 million at June 30, 1960, the limited significance of the resources of the Development Bank can be gauged, and the warning of Dr. H. C. Coombs (1959), that too much should not be expected of it, is seen to be well-founded.

Extension Needs

It is well known that capital and knowledge are complementary resources. The familiar proposition that "with your money and my brains we could go places" recognises this relationship. The effectiveness of extension education to agriculture is limited if capital is not available to adopt improved technology. Conversely, efficient use of capital demands adequate knowledge of production possibilities and techniques.

Paralleling the growth of capital requirements in agriculture has been an increase in the complexity of modern farming. The harnessing of science to the plough does not make everything simple for the farmer; on the contrary, it demands of him a much higher level of management, knowledge, and technical skills than formerly. Economic considerations also enter more obviously into the decision-making process than they used to do, as farming changes from a way of living to a way of making a living.

These changes call for adaptation and improvements in our extension services and other agricultural education facilities. The development of new institutions to fit the changing circumstances may well be required as in the case of capital considered above.

One new institution that has been introduced into Australia to meet this problem is the farm improvement club, in which a group of 40 to 50 farmers employ their own agricultural adviser, as at Bombala, N.S.W., or Brunswick, Western Australia. The farm improvement club represents an attempt by farmers to achieve a more intensive advisory service in management decisions than the thinly-spread State extension agencies can ever hope to provide, and often reflects a determination to achieve more fully a whole-farm approach to planning and decision making. At this stage, however, one could not hold out the hope that farm improvement clubs are likely in themselves to provide an answer for more than a small proportion of farmers.

One major weakness in our present agricultural extension services arises from the apparently deeply-embedded urge to fasten "approved" or "not approved" tags to specific farm practices. As a result many agricultural scientists have a misconception about the role of agricultural economists. They are inclined to think the farm economist is going to provide the labels for them. The vision of the extension process involved is that it falls easily into three steps. At the apex of the structure the agricultural scientist develops new techniques. The farm economist then performs a few accounting operations and verifies that the returns are greater than the costs. The stamp of approval is then fastened to the practice and the task of the extension worker is simply to get the certified techniques across to the farmer.

This is a quite misleading view of the responsibility of agricultural extension, and if the farm economist is cast in the role of accessory he should decline. Not only does it give no scope for the application of economic principles, it is quite contrary to them. The economist cannot, any more than anyone else, completely prefabricate standardised decisions for optimum resource-use to suit all farms.

Perhaps it is this vision of the process which gives rise to the philosophy of many people in farm extension that their job is essentially one of salesmanship, that their success is measured by the number of farmers they can persuade to adopt recommended practices, and that the ideal extension service is one that minimises the lag between research discoveries and their adoption by farmers. This attitude contrasts sharply with the typical philosophy among extension workers in America. Advice to the farmer is there envisaged not so much as urging the farmer to do something, but as helping him to make his own decisions by providing him with all available information and by educating him to make better use of it. This is not only a more valuable philosophy but is far more likely to win the farmers' continued confidence in extension.

In view of the doubtful perspective of some workers in the extension field it is pleasing to observe that at last in this country formal training in extension has recently been instituted by the University of Queensland, which is to offer a post-graduate diploma in this field. The philosophy of our agricultural advisory services and the status of extension as a profession could benefit greatly from the establishment of similar centres at other Universities.

Changing Institutions in Marketing

Marketing institutions are no exception to the dynamic state of affairs encountered in the fields of capital and agricultural education. Major adjustments to meet changing conditions are similarly called for.

One of the principal changes now in process in Australia is in the economic organisation of retail food marketing. A good deal of vertical and horizontal integration has been taking place with the entry of the general merchandise chain-stores into retail food marketing and their recent large-scale take-overs of the older grocery chains and of wholesaling facilities. Indeed there is something of a revolution in retail food marketing in progress. The trend is towards the supermarket, featuring a full range of food products to permit one-stop shopping, the self-service principle with goods displayed on open shelves or in open refrigerated cases, and a large turnover at a lower average percentage mark-up than the older type of grocery store. In the United States the supermarket has largely displaced the kind of

food store previously common, and has had very far-reaching implications for agriculture and the food processing industries. Among the associated changes affecting agriculture are the following:

(a) growth of direct contracts between producer-suppliers of perishable products and retail distributors;

(b) increased flexibility in retail prices, arising from the use of perishable commodities in temporary over-supply as "specials." (The performance of the market in clearing supplies in glut conditions greatly improved as a result.)

(c) preference for repeatable lines, because of less personal contact between client and retailer, has contributed to the spread of grade marking of beef and other perishables;

(d) extensive changes in packaging and presentation of food products followed the introduction of the self-service principle because of the necessity for "eye-appeal" to encourage impulse buying;

(e) more recently there has been a growth in the share of the market obtained by retailers' private brands at the expense of nationally-known brands of products. Retailers have either integrated vertically backwards to establish their own processing plants or have compelled processors to pack retailer-brands at prices enabling them to undersell nationally advertised processor brands.

Changes in marketing organisation in Australia are taking place not only in retail distribution but at other levels. We do not know just how the concentration of economic power in our food processing industries is changing as a result of vertical and horizontal integration, the direct investment of foreign capital in such fields as dairy products, breakfast foods, fruit and vegetable canning and the extension of operations by flour millers into ready-mixed feeds, etc. But frequent reports of take-overs and attempted take-overs in these fields suggest a rather dynamic situation.

We should be keeping these and similar trends under continuous observation and undertaking research to determine the economic consequences. Our primary industries should be doing some hard thinking about how they can best adjust to changing marketing institutions and conditions.

A producers' co-operative was set up in Victoria a few years ago to establish an abattoir and to integrate through to the control and operation of twenty retail butcher shops. This development was apparently prompted by the dissatisfaction of producers with the lamb prices they received and the belief that the price-spread between producer and consumer was excessive. Producer co-operatives have often failed in similar undertakings in meat and other industries. The N.S.W. Banana Growers Federation, for example, incurred heavy losses in establishing its own retail store in Sydney a few years ago. In spite of such experiences, producers are often inclined to think that establishing their own retail outlets is the way out of all their marketing difficulties. For example, growers of peas and beans in one coastal district in N.S.W. have recently been suffering severely from competition of deep-frozen peas and beans which are available throughout the year and thus destroy the seasonal premium which previously made these crops payable in that district. The idea of opening pea and bean shops in Sydney was reported to be under consideration.

Primary producers would be much better advised to think of how they can turn the revolution in retail marketing of food to their advantage than to add to the number of one-commodity shops in an era of one-stop shopping. Meat producers in Victoria might well have found that a better alternative than trying to control 20 separate retail units would have been to develop a new kind of enterprise altogether, catering for the new form of retail food store. In other words, establishment of a central pre-packaging plant to serve a number of large self-service food markets with meat may have proved a better proposition, especially in the long run.

Decision-making by producer groups on marketing problems would undoubtedly be assisted greatly if there were a sizeable amount

of marketing research going on in Australia, and if, instead of such regular features as "Co-operation — A Pillar of Democracy," telling how the co-operative way of life makes for a more complete personality, our rural newspapers carried extension articles, reports of findings of marketing research, and other information designed to help primary producers either to run a successful co-operative or to decide against ill-fated co-operative enterprises as the case may be.

Marketing research in agricultural products is undertaken by a number of bodies including the State Departments of Agriculture, the Bureau of Agricultural Economics, C.S.I.R.O., and the Universities. In the Universities at least, it appears to be more difficult to obtain financial support for research in marketing than for research into "on-farm" problems. This is partly a reflection of the current over-readiness of industry bodies to hand over the job of marketing research entirely to commercial consultants, a trend which augurs poorly for the future availability of properly-trained marketing specialists and for the quality of work done in the name of marketing research.

I consider that the resources of all of the above agencies should be strengthened. However, a less piecemeal approach to agricultural marketing problems than hitherto is desirable and this would, in my view, best be achieved by the establishment of a federal agricultural marketing service with specific responsibility for the task.

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PLANT VARIETIES AND SPECIES IN RELATION TO THE OCCURRENCE OF DEFICIENCIES AND EXCESSES OF CERTAIN NUTRIENT ELEMENTS

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It is now recognized that the occurrence of disorders in plants due to deficiencies or excesses of nutrient elements may be affected to an important degree by the species or varieties involved. Thus it has been found that plants may differ in "feeding power" (i.e. the capacity to extract nutrients from relatively unavailable sources) or in the efficiency of utilization of absorbed nutrients.

In many instances varietal differences within species have been found to be greater than differences between related species or genera.

Although numerous examples are now known of such varietal and species effects, the full evaluation of the possibilities of utilizing this phenomenon for the control or alleviation of various nutrient disorders still requires considerable work.

The following survey is not claimed to be a complete cover of the literature, but is intended to indicate the type of results which have been achieved, in the hope of stimulating further interest in this aspect of plant nutrition.

Boron Deficiency

Differences in boron requirement and tolerance between the Gramineae and dicotyledons have been observed. In general, the former have the lower boron requirement (Bertrand and DeWaal 1936; Bertrand and Silbertstein 1937; Anon 1937b, 1938; Schropp 1940; Hirai 1948; Berger 1949; Shkol'nik and Makarova 1949).

This lower requirement for boron in the Gramineae as compared with the dicotyledons is associated by Schropp and Arenz (1940) with the lack of a secondary growth in stem thickness in the former. One effect of boron deficiency in plants is an abnormal development of the cells of the cambium zone (Warington 1926; Struckmeyer and McVicar 1948; Millikan 1953a).

In the dicotyledons, susceptibility to boron deficiency varies considerably between species and varieties. Such differences for boron deficiency have been reported between different varieties of beets and between beets and swede turnips (Brandenburg 1939, Walker, Jolivette, and Hare 1945; Kelly 1960), cotton (Schropp and Arenz 1939), celery (Yamaguchi, Zink, and Spurr 1953; Yamaguchi and Minges 1956; Lingle and Carolus 1956), flax (Taubock 1941), peanut (Harris and Gilman 1937) and vines (Scott 1944; Wilhelm 1952). Barnes and Jones (1956) described varietal differences in leaf symptoms in vines due to boron deficiency.

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The development of boron deficiency symptoms in the presence of trace amounts of boron was observed by Eaton (1944) and Ghandi and Mehta (1960) in some species of plants and not in others. Vittum (1940) has also reported differential responses to boron applications between a number of vegetable species and alfalfa, while Rogers (1947) observed similar differences in response to borax in field trials with various legumes.

Little work has been done on the basis for these differences in susceptibility to boron deficiency. Brandenburg (1939) attributed the varietal differences in heart rot susceptibility in beets to the greater ability of the resistant varieties to extract boron from the soil, while Kelly (1960) observed that strains of red beet most susceptible to boron deficiency tended to accumulate the largest amounts of calcium in the young leaves.

Scott (1944) could not correlate the inherent vigor of growth of vine varieties with differences in the severity of boron deficiency symptoms.

The inheritance of susceptibility to boron deficiency in celery has been investigated by Pope and Munger (1953b) and shown to be conditioned by a single recessive gene.

Boron toxicity

The relative tolerance of different species of plants to excessive amounts of boron in the substrate has also been investigated. Thus Skinner, Brown, and Reid (1923) found the sensitivity to excess boron of four crop plants to be in the following order of decreasing sensitivity: corn, beans, cotton, potatoes. Later Eaton, McCallum, and Mayhugh (1941) and Wilcox (1960) classified some 53 plant species for tolerance to boron. Eaton (1944) also grew over 50 species of plants in sand cultures with graduated amounts of boron from a trace to 25 p.p.m., and classified the plants as sensitive, moderately sensitive or tolorant to boron. There appeared to be little relation between boron tolerance and the boron accumulation characteristics of different plants. Also there appeared to be a seasonal factor involved, as some plants accumulated more boron when grown in summer, while others accumulated more when grown in winter.

The results of Hansen (1945) agree with those of Eaton *et al* (1941) in that he found the semi-tolerant olive did not accumulate as much boron in its leaves when the supply of this elements was excessive, as did the blackberry, fig, and grape, which were classed as boron sensitive.

Purvis and Hanna (1938, 1940) studied the effects of dressings of up to 50 lb per acre of borax to different crop plants growing on a range of soil types. A gradation in the reactions of the plants to the high boron dressing of very sensitive to very tolerant was recorded.

Turnips were shown by Page and Paden (1949) to be much more tolerant to high applications of sodium or calcium borates than snap beans or crimson clover. Similarly, Schroeder and Peck (1959) observed that peas and beans could be injured by boron applications which were beneficial to beets.

Tobacco was less sensitive to excess boron than Indian bean, onion, *Pennisetum sp.*, or *Cyanopsis sp.* in sand culture experiments by Gandhi and Mehta (1960), while Gisiger and Halser (1948) found oats to be more tolerant to boron than barley.

In the Netherlands Henkens (1958) has stated than agricultural crops most sensitive to a deficiency of boron are most tolerant to boron excess.

The type of rootstock has been shown to have an important influence on the occurrence of boron deficiency, on the amount of injury caused by an excess of boron in the substrate, and on the accumulation of boron in the leaves and stems of grafted citrus (Eaton and Blair 1935; Haas 1945, 1947, 1948; Penman and McAlpin 1949; Smith, Ruether, and Specht 1949; Cooper, Gorton, and Olson 1952; Smith 1954), prune and plum (Hansen 1948) and almond and peach (Hansen 1955).

Calcium Deficiency

Differences in calcium requirement between plant species has been described by De Turk (1941), Price, Linkous, and Hill (1946), Cooper

et al (1948a) Hou and Merkle (1950) and Thomas *et al* (1952). Grain crops and grasses are generally lower in calcium than legumes. The latter thus show symptoms of calcium deficiency more readily than the former.

However, within the Gramineae a varietal difference in calcium requirement has been recorded by De Turk (1941) who found that for normal growth to occur an inbred strain of corn required 50 p.p.m. of calcium in the substrate, whereas an open-pollinated variety required only 10 p.p.m. Differences in the comparative effects of different calcium levels on several grass species have been recorded by Bradshaw *et al* (1960).

Some legumes (e.g. red clover) are intolerant of acidity and are unable to absorb sufficient calcuim ions at low pH values (Crane 1926). Similarly, two strains of *Lespedeza* which differed in their ability to grow on acid soils were found by Morris and Pierre (1949) to have different calcium requirements.

Andrew and Norris (1961) compared the responses to calcium exhibited by five tropical and four temperate legumes, respectively. It was concluded that the tropical species had a superior ability to extract calcium from the soil.

In a water culture experiment Millikan (1953a) observed a significant difference in the effects of the same degree of calcium deficiency on two varieties of subterranean clover.

Certain varieties of cotton appear to be more sensitive to calcium deficiency than a number of other species of plants; including oats, corn, peas, lima beans, vetch, soy beans, and peanuts (Presley and Leonard 1948). When grown under the same conditions, cotton plants were found to contain a higher concentration of calcium than wheat (Cooper *et al* 1948b), but not turnip (Mehlich and Reed 1948). The latter workers further showed that cotton required a much higher concentration of calcium in the substrate than did soy beans.

Differences in calcium uptake or requirement have been reported within species. Thus marked differences in calcium content have been recorded between varieties of wheat (Greaves, Bracken, and Hirst 1940; Anon, 1942) and date palms (Haas 1947). Millikan (1951) was able to select from susceptible varieties strains of flax which showed resistance to withertop (calcium deficiency disease).

With white clover Robinson (1942) found that different clones showed consistent differences in calcium concentration when grown on different soils.

In sand culture experiments with tomatoes grown at different calcium levels, Maynard and Barham (1957) observed that at a moderate deficiency of the element two varieties exhibited differences in a blossom end rot incidence.

Copper Deficiency

The identification of the cause of "reclamation" disease in cereals as copper deficiency led to observations on the relative effects of the deficiency on different plant species. The disease was found to severely affect oats, wheat, and barley, whereas rye was either unaffected or only slightly affected (Riceman and Donald 1938; Piper 1938; Mulder 1940; Teakle *et al* 1940; Toms 1958a). Sorteberg (1948) agreed that oats and barley may be severely affected and rye seldom, but states that wheat is rarely injured by reclamation disease. Teakle, Turton, and Throssell (1940) also observed that maize responded to copper and suggested it as an indicator plant for copper deficiency, but Brown (1955) found that maize showed only moderate symptoms when wheat was severely affected by copper deficiency. Also, copper was not recommended for maize on Michigan soils where other plants gave responses to this element (Anon. 1937a). These reported differences in the effects of copper deficiency on maize could well be due to the different varieties concerned.

Riceman (1948) observed that on Laffer Sand in South Australia, subterranean clover and lucerne required copper, but *Phalaris tuberosa* gave no response to this element.

The natural flora of the copper deficient soils included inferior grasses such as hare's tail grass (*Lagurus ovatus*) and madrid brome grass (*Bromus madritensis*) (Riceman and Donald 1938, 1939), flat weed (*Hypochaeris glabra*), drake (*Lolium temulentum*) and *Cotula australis* (Teakle *et al* 1940). The

latter also observed that wild radish (*Raphanus raphanistrum*) made good growth early, but failed to flower normally on the deficient soil. Yorkshire fog grass (*Holcus lanatus*) will also thrive on soils where other species require copper for normal growth (Anderson 1946; Parle 1958). Melchers and Gerritsen (1944) also observed *Holcus lanatus* as well as sheep's fescue (*Festuca ovina*), march bent grass (*Agrostis alba*) and palish white clover as common species on copper deficient soil.

Rademacher (1940) reported differences in susceptibility to reclamation disease between varieties of oats. Previously he had found that *Avena strigosa* was resistant (Rademacher 1937).

Greaves and Anderson (1936) report copper contents ranging between 5.6 and 16.7 p.p.m. for sixteen wheat varieties grown on the same soil. The copper contents of a number of grasses and forage crops at different stages of growth were determined by Datta and Datta Biswas (1951) and differences between species at the flowering stage were noted. Significant differences in copper content between species of pasture plants were also found by Moore (1950) and Dick, Moore, and Bingley (1953).

Chester, Marriott, and Harvey (1957) observed that paspalum and white clover maintained a higher level of copper than did narrow leaved carpet grass (*Asconopus affinis*) which was the predominant species on the copper deficient soils. A comparison between the copper contents of grass and legume hays from soils deficient in copper by Stenberg and Ekman (1948) revealed a somewhat higher concentration in the legumes.

Seed size has been shown to be important in the development of copper deficiency symptoms in legumes, the large seeded legumes being less liable to the deficiency owing to their greater reserves of copper (Hewitt and Jones 1952b; Hewitt, Jones, and Miles 1954). Hewitt and Jones (1950) studied the relative effects of copper deficiency on yield of five species of plants. The order of increasing yield depression was tomato, swede, alsike clover, sugar beet and oats. Of these species, tomato and oats were found to be good indicators of the deficiency.

Differences between legume species with respect to their susceptibilities to copper deficiency have been reported. Lucerne has been shown to be very susceptible by Piper (1942), Trumble and Ferres (1946), Anderson and Neal-Smith (1951), Millikan (1953b), Hewitt, Jones and Miles (1954), and Tiver and Webber (1957). In field tests Anderson (1946) obtained responses to copper in subterranean clover and lucerne, but not in *Phalaris tuberosa* and white clover. Dwarf bean, a large seeded species, was found by Hewitt and Jones (1951) to be relatively susceptible to copper deficiency. Brown (1955) reported that two varieties of soy beans did not respond to copper under conditions where wheat developed severe symptoms of reclamation disease.

Field observations by Parle (1958) showed differences between three legumes as regards copper requirements on deficient soils. *Lotus major* survived without the addition of copper, white clover grew when 5 lb of copper sulphate per acre were applied, but not red clover. The latter species became dominant when 20-40 lb per acre of copper sulphate were applied.

Similarly, Riceman and Powrie (1952) compared the performances of over 100 species and varieties of *Pisum, Vicia, Lathyrus* and *Lupinus* on Coonalpyn Downs in South Australia. Some species and varieties in all genera except *Lupinus* gave promising results.

On acid muck soils in Michigan highest responses to copper applications were obtained with spinach, onions, lettuce, carrots, potatoes, tomatoes, cauliflowers, and radish, whereas little or no response occurred with celery, corn and rutabagas (Anon. 1937a). Mulder (1940), however, classed potatoes as comparable with rye with respect to resistance to copper deficiency.

Differences in varietal susceptibility to copper deficiency have been noted in apples (Dunne 1938; Bould *et al* 1950).

A difference in copper content between the young leaves of two varieties of grapes has been reported by Magoon *et al* (1939).

The basis for differences in susceptibility to copper deficiency between plants has received some attention by Rademacher (1937). He found that resistant strains of *Avena* contained a higher copper content than susceptible

strains on the poor soils, owing to their greater capacity to extract copper from such soils. On normal soils the copper contents of the different varieties showed no such difference. Mulder (1940) also found that resistant plants had a greater power of extracting copper of low solubility from poor soils.

Iron Deficiency

An early observation on a difference in species susceptibility to iron deficiency was made by Riviere and Bailhache (1910) to the effect that pears growing in high-lime soils were more susceptible to iron chlorosis if grafted on to quince rootstocks. This observation on the effect of the rootstock was later supported by Hendrickson (1924) who stated that pears on *Pyrus communis* rootstock were more resistant to iron chlorosis than those on *P. serotina* or quince. From observations made in Victoria Baxter (1960) has listed the commonly grown fruits in order of their susceptibility to iron chlorosis. He lists vines in the resistant class.

Casale (1935), however, observed that American vine varieties were more affected by chlorosis as they were apparently less able to take up iron than were European varieties, while Bryant and Beach (1941) have classified 42 grape varieties on the basis of their resistance or susceptibility to iron deficiency chlorosis. Varietal differences in susceptibility to iron deficiency have also been recorded in potatoes (Berkner 1936) and subterranean clover (Millikan 1953a), while Wann (1943) has observed differences in the occurrence of iron deficiency chlorosis in various ornamental shrubs.

Weiss (1943) found that the efficiency of iron utilization and susceptibility to iron deficiency chlorosis varied considerably between soy bean varieties grown on calcareous soils, and further, that inefficiency in iron utilization was conditioned by a single recessive gene.

Later Brown and Holmes (1955, 1956) confirmed that differences exist between the susceptibility of soy bean varieties to iron deficiency chlorosis, and also that soy beans, wheat, and corn differed in the concentration of available iron required in the media to prevent the development of chlorosis.

Further studies were made on the nature of this varietal difference in soy beans. Reciprocal grafts of tops and roots between two varieties differing markedly in their abilities to obtain enough iron from certain soils showed that the variety used for the root system determined whether the plants became chlorotic. Thus the varieties differed in their capacity to absorb iron rather than in any difference in degree of inactivation of iron in the tissue (Brown, Holmes, and Tiffin 1958).

It was further shown that the chlorosis susceptible and non-susceptible soy bean varieties differed in their capacities to absorb iron from a chelating agent (Brown and Tiffin 1960). There is apparently a relationship between the reductive capacity of soy bean roots, their capacity to absorb iron, and the susceptibility of the plants to iron deficiency chlorosis (Brown Holmes, and Tiffin 1961).

Brown, Tiffin, and Holmes (1960) and Brown *et al* (1961) further showed that the capacity of plant species to absorb iron from chelating agents differed. The minimum concentration of iron in the substrate for healthy growth was also found to be dependent on plant species, as well as other factors (Oertli and Jacobson 1960).

Olsen (1958) studied the iron nutrition of "acid soil" and "basic soil" plants, respectively; when ferric sulphate was the source of iron, the former developed iron deficiency chlorosis at pH values above 6.0, whereas, the latter showed symptoms of iron toxicity at pH 4.0. It was concluded that the "acid soil" plants probably absorbed ferric ions at a much slower rate than the "basic soil" plants.

Magnesium Deficiency

Sommer, Wear, and Baxter (1940) and Sommer and Baxter (1942) reported considerable differences between the effects of magnesium deficiency on certain plant species. The increasing order of susceptibility to the deficiency was corn (vegetative stage), turnip, cotton and crimson clover, crotalaria and peanuts. In the latter instance the deficiency of magnesium affected yield of nuts more than top growth. Inbred lines of corn known to differ widely in the ability of their leaves to accumulate magnesium were studied by Foy and Barber (1958). It was found that the inbred with the low leaf magnesium content immobilised this element

in the stems. Magnesium deficiency was also found to differentially reduce the carbohydrate content of two types of cotton (Helmy, Joham, and Hall 1960).

In experiments by Weber (1959), tomato, potato, celeriac, cucumber, bean, mangold, swede turnip and yellow mustard, growing under field conditions developed symptoms of magnesium deficiency, whereas oats were unaffected. However, Messing, Hobson, and Winsor (1957) have stated that a wide range in susceptibility to magnesium deficiency is known to exist between tomato varieties.

Celery varieties were also shown to differ in susceptibility to magnesium deficiency (Davis and McCall 1953; Pope and Munger 1953a). As a result of genetical studies the latter concluded that magnesium utilization in celery was conditioned by a single dominant gene.

Magnesium uptake of wheat varieties grown in the Nile Valley was determined by Schrumpf-Pierron (1932). The concentration of this element was found to vary with the variety, and not with the magnesium content of the soil.

Differences between grape varieties in the severity of magnesium deficiency symptoms and the magnesium content of the leaves was found by Scott and Scott (1951). Magoon *et al* (1939) had previously observed differences in magnesium content of the leaves of two grape varieties.

In a series of water culture experiments significant differences in the effects of a deficiency of magnesium on growth have been recorded between three varieties of subterranean clover (Millikan 1953a), and between various species of pasture legumes (Millikan 1961).

With respect to fruit trees, observations by Mulder (1947) suggest that apples may be more susceptible to mangesium deficiency than pears.

Manganese Deficiency

Observations were made by Davies and Jones (1931) on the relative susceptibilities of varieties of oats to a disease which was first believed to be halo blight caused by *Bacterium coronafaciens*, but which was later identified as manganese deficiency or "grey speck". The reactions of the varieties to "grey speck" varied from high resistance exhibited by Scotch Potato oats to high susceptibility in the variety Orion. This and later work by Rademacher (1935) focussed attention on the occurrence of differences in reaction to "grey speck" (manganese deficiency) disease in cultivated oats and other species of *Avena*. Rademacher found that the varieties of *A. sativa* which he tested ranged in reaction from extreme susceptibility to high resistance, although none was entirely immune. There were similar differences in the reactions of other *Avena* species. *A. sativa pregnax* was very susceptible, *A. byzantina* moderately resistant and *A. barbata, A. strigosa* and *A. brevis* were resistant.

Subsequent observations by different workers have confirmed the existence of variations in susceptibility to "grey speck" between cultivated oat varieties and other species of *Avena*. (Steenbjerg and Boken 1939; Gallagher and Walsh 1941, 1943a, 1943b; Hagborg 1947; Thurston 1951; Tedin and Gelin 1952; Gerretsen 1956; Ryan 1958; Toms 1958b, 1959; Vose and Griffiths 1961). Thurston (1951) noted a difference in the leaf symptoms of manganese deficiency shown by *A. luoviciana* as compared with *A. fatua* and two cultivated varieties. Finch (1954) found no differences in susceptibility to manganese deficiency between the oat varieties he studied.

Where the manganese deficiency was acute Gerretsen (1956) observed that even the "resistant" oat varieties became stunted and showed "grey speck" symptoms before dying.

Other cereals and grasses have also been shown to exhibit differences within and between species. Sorteberg (1948) found that the barley, wheat, and rye varieties he used were not as severely affected by manganese deficiency as oats. Jones (1957) and Smith and Toms (1958) also observed that rye was much less susceptible to the disorder than oats. However, such differences between species are not necessarily consistent. Thus Gallagher and Walsh (1943a 1943b) found that oats, wheat, barley, and rye showed great variation in the severity of manganese deficiency symptoms between different varieties of the same cereal.

Similarly, in two separate trials Ryan (1958) observed that Atlas and Beecher barleys gave

higher disease ratings than sixteen oat varieties also included in his tests.

The susceptibilities of certain grass species and strains to manganese deficiency were compared by Walsh (1945) who found similar differences in reactions to those outlined above for cereals. He concluded that some species and strains of grass may be as sensitive to manganese deficiency as the most sensitive wheat and oats varieties, and much more so than the least sensitive of these.

Legumes may be as sensitive to manganese deficiency as cereals. For example, Nicholas (1949) observed severe symptoms in both peas and oats. However, variability in the severity of symptoms between different species grown in the same substrate has been reported. Thus, at Rhode Island, annual sweet clover was observed to remain free of manganese deficiency symptoms whereas, lucerne, red clover, alsike clover and oats were restricted in growth by the deficiency (Anon. 1927). Similarly, Jones (1957) found that oats grown in a manganese deficient soil in pots showed symptoms of the deficiency whereas, vetch and rye remained unaffected. Of the three species, vetch showed the greatest uptake of manganese.

Manganese deficiency symptoms in peas and beans are usually called "marsh spot", the name referring to the symptoms in the seed. It has been shown by Hewitt (1945) that certain legumes (e.g. dwarf beans and haricot beans) may show very severe leaf symptoms and yet remain free from marsh spot phase. He found peas to be very susceptible, and broad beans and scarlet runner beans more resistant, to "marsh spot".

In tests with two varieties of peas Koopman (1937) found the Jumboka variety to be much more susceptible to "marsh spot" than the variety Zelka. More extensive tests by Glasscock (1941) and Walsh and Cullinan (1945) confirmed that pea varieties differ in their susceptibilities to "marsh spot". Both showed that the variation in the "marsh spot" reactions between the varieties included in their tests was considerable. Some varieties were unaffected or very resistant, whereas others proved to be very susceptible to the disease. Ozaki (1955) reports differences in response to manganese sprays applied to correct manganese deficiency in beans and peas. Whereas visual symptoms of the deficiency were corrected by sprays in both hosts, improvement in growth and yield was obtained only with beans.

Significant differences in the effect of manganese deficiency in the growth of three varieties of subterranean clover have been described by Millikan (1953a).

There appears to be little reported evidence of differences in susceptibility to manganese deficiency between fruit trees.

Connor (1954) observed that Washington Navel organes on Sweet Orange root stock had a lower level of manganese, and showed more visual symptoms of manganese deficiency than trees on Rough Lemon stock. In Victoria peach trees may be the first trees in an orchard to be affected by a deficiency of manganese, particularly the varieties J. H. Hale, Beale, and Wiggins (Baxter 1959).

Manganese deficiency of vegetable crops in Victoria has affected principally crucifers, red beet, parsnips, peas, beans, and cucurbits (Skene and Kefford 1955).

The manganese content of numerous species of plants has been determined by various workers. Considerable variations may occur within and between species (e.g. Brunstetter *et al* 1939; Wain, Hunt, and Marsh 1939; Kenworthy 1950; Ichakawa and Seo 1953). McHargue (1945) concluded that leguminous plants usually contain less manganese than grasses. However, seeds of monocotyledons and dicotyledons were found to be relatively uniform in manganese content by Bertrand and Silberstein (1953).

The nature of the resistance of cereals to manganese deficiency has received some attention. Steenbjerg and Boken (1939) found that the manganese content of resistant oats was lower than that of susceptible varieties. Under conditions of low manganese supply, the coefficient of utilization (i.e. ratio of absorbed manganese to dry weight) was highest in the resistant group. The differences in this coefficient between the resistant and susceptible groups became less as the level of manganese in the soil increased.

Tedin and Gelin (1952) also showed that a tolerant oat variety had a greater coefficient of utilization of manganese than susceptible

varieties rather than an ability to utilize less available forms of manganese in the soil. Vose and Griffiths (1961) on the other hand suggested that susceptibility to grey speck in oats was due primarily to a lack of mobility of manganese within the plant.

Gerretsen (1956) observed that resistant oat varieties had a greater uptake of CO_2 and better root systems, both in water cultures and soil deficient in manganese, than susceptible varieties.

Manganese Toxicity

Differences in the tolerances of plants to high concentrations of manganese in the substrate have been reported in the literature.

On manganiferous soils in Hawaii Kelley (1909) observed that good crops of sugar cane could be grown where the growth of pineapples proved unsatisfactory. Another graminaceous plant (maize) was later found by Olsen (1936) to be tolerant to manganese in water cultures, whereas *Lemna polyrrhiza* was injured by a concentration of 0.5 p.p.m.

Oats and barley were relatively tolerant to high manganese levels in tests by Hewitt (1948, 1952) and Kenten and Mann (1957), while similar observations were made by Millikan (1949) and Lohnis (1951) for oats, and Turchin and Sokolov (1950) for rye and oats. Manganese at a concentration of 5 p.p.m. was found to be toxic to soy bean, but not to corn by Hernandez-Medina and Lugo-Lopez (1958).

Hopkins, Pagan, and Ramirez Silva (1944) observed pineapples in Puerto Rico to be less sensitive to manganese toxicity than tomatoes or beans. Similarly Hewitt (1948, 1952) found tomatoes and French beans, as well as potatoes and most brassicas, to be very susceptible to excess manganese. Hewitt (1952) classed celery, carrot, flax and sugar beet as relatively tolerant, but Turchin and Sokolov (1950) found sugar beet together with lucerne and millet to be sensitive to excess manganese. In water cultures, Kenten and Mann (1957) found tomatoes and sprouts to be more affected by excess manganese than peas, whereas barley survived at high concentrations. In tests in water cultures and in the field Lohnis (1951) obtained the following results: Very susceptible: *Phaseolus vulgaris, Vicia sativa, Medicago sativa;* Tolerant: *Trifolium pratense, T. repens.* Marigolds proved sensitive in a field test, while other plants found to be tolerant included flax, potatoes, tobacco, mustard, oats, strawberry, *Vicia faba* and grape. Millikan (1949), however found flax to be more sensitive than oats.

The differences between the results reported above with respect to the tolerance of sugar beet, potatoes and flax could be due to varietal differences.

The importance of varietal differences in ability to tolerate high concentrations of manganese has been demonstrated for lucerne by Dessureaux and Ovellette (1958), Ovellette and Dessureaux (1958), and Dessureaux (1958, 1959). Millikan (1953a) also observed varietal differences in growth of subterranean clover in nutrient solutions containing excess manganese.

Morris and Pierre (1949) studied the manganese tolerance of several legume species in solution cultures. They found the order of decreasing sensitivity to manganese between species to be: lespedeza, sweet clover, soy bean and cowpea, and peanuts. However, two strains of lespedeza with differing abilities to grow on acid soil, were found to have different calcium requirements as well as tolerances to manganese.

Species differences between ornamental plants have been described by Coorts (1958). The most sensitive of the plants studied were chrysanthemum, calendula and antirrhinum — the latter two species being recommended as indicator plants for excess manganese. Carnation, poinsettia and rose were more tolerant of manganese.

Apple varieties also exhibit marked differences in their ability to absorb and to tolerate high levels of manganese without symptoms of internal bark necrosis (Orton and Clulo 1950).

Some observations have been made on the reasons for the differences in tolerance or susceptibility to manganese between plants. Age of plants appears to be a factor, as pineapple (Kelley 1909) and lucerne (Dessureaux 1958) have been reported as becoming more affected with age.

Morris and Pierre (1949) and Lohnis (1951) found that species differed in their capacity to absorb manganese, but such differences were not necessarily related to their yield in a manganiferous substrate. Tolerance could be due to weak absorption or, more probably, to tolerance within the plant.

Clones of lucerne which exhibited differences in manganese tolerance, were shown by Ovellette and Dessureaux (1958) to absorb approximately equal amounts of the element, but to differ in the rate at which they translocated it from roots to tops. Thus tolerant varieties had relatively more manganese in roots than in tops.

High-valency forms of manganese were demonstrated in peas grown in the presence of excess manganese by Kenten and Mann (1957) but not in tomatoes, sprouts or barley. It was suggested that in the latter plants these forms of manganese are reduced as fast as they are formed.

Molybdenum Deficiency

Following the recognition of the whiptail symptom in cauliflower as being due to molybdenum deficiency, field observations showed that cauliflower varieties differed considerably in their susceptibility to this deficiency in the United States (Raleigh 1950; Gammon *et al* 1954), Australia (Waring, Wilson, and Shirlow 1948, 1949; Morgan and Henderson 1950), and England (Neenan and Goodman 1954).

In some culture experiments with different plant species, Hewitt (1952) classified brassicas together with lettuce, tomato and sugar beet as being highly susceptible to molybdenum deficiency. However, Hewitt and Jones (1952a), Plant (1953), and Neenan and Goodman (1954) showed that considerable differences between brassicas occured with respect to their relative susceptibilities to molybdenum deficiency.

Hewitt (1952) classified clovers and lucerne as moderately susceptible to molybdenum deficiency and large seeded legumes, oats, and potatoes as having a low requirement for this element. Hewitt and Jones (1952b) also placed grasses in this last category. Plant (1952) found that rape, oats and potato showed no symptoms of molybdenum deficiency even under very acid soil conditions.

Johnson, Pearson, and Stout (1952) studied thirty different plant species and found that none of the legumes or grasses included required molybdenum, whereas the remaining eighteen species did. Seed borne molybdenum could have been a factor in the case of the legumes. In this regard Meagher, Johnson, and Stout (1952) point out that molybdenum is unique among essential elements in that seeds may supply up to ten times the nutritional needs of the mature plants. Healthy cereal plants (barley, maize, oats, and wheat) were found to have appreciably lower molybdenum concentrations in their leaves than affected tomato, sugar beet, squash, or spinach plants.

Kretschmer and Allen (1956) observed that variety may have a pronounced effect on the molybdenum content of plants. Similarly, Moore (1950) and Dick, Moore and Bingley (1953) found significant differences between pasture species with respect to their molybdenum contents. Uptake of molybdenum showed considerable variation between species, being highest in legumes and annual grasses and least in *Heliotropium europaeum* (Dick 1953). Robinson and Edington (1954), however, found that legumes were not consistently high in molybdenum when compared with other plants. Vinogrodova (1953) made a study of the molybdenum content in different legume families. The Papillionaceae and Mimosoideae were relatively high in molybdenum, the Caesalpinioideae low, and the Sophoreae were intermediate between these two groups of families.

The existence of a difference between subterranean clover and *Medicago* species with respect to their molybdenum requirements for active growth and nitrogen fixation has been indicated by the results of field trials and pot tests by Andrew and Milligan (1954). Whereas subterranean clover made good growth of a healthy green colour, the medics were stunted and yellow, but they developed a normal green colour and grew vigorously following the application of molybdenum. It was further observed that the yellowing and dying of the medics varied between and within species.

Differential responses to molybdenum treatment by lucerne varieties growing on a highly manganiferous soil have been reported by Younge and Takahashi (1953).

The severity of molybdenum deficiency in citrus in Florida has been reported by Stewart and Leonard (1952) to be affected by root stock. Trees on grape-fruit root stocks were more seriously injured than trees on other rootstocks.

Zinc Deficiency

The relative effects of zinc deficiency between legumes and other plant species have been studied by various workers. Reports indicate that lucerne possesses the ability to grow on soil where other species develop symptoms of zinc deficiency. Thus Hoagland, Chandler, and Hibbard (1936) found that lucerne was much less susceptible to zinc deficiency than apricot, tobacco, squash, maize, mustard, tomato, sunflower, or cotton. Also interplanting lucerne between vines (Ballard and Lindner 1934) or maize or apricot seedlings (Hoagland, Chandler, and Stout 1936) growing in "little leaf" soil, considerably reduced the severity of zinc deficiency symptoms in these species.

In certain soils in South Australia zinc has given outstanding results with subterranean clover, whereas this element has either produced little or no growth response in lucerne (Anderson 1946; Riceman 1948; Tiver and Webber 1957), or has even appeared to suppress its production (Tiver 1958).

Water or sand culture experiments have confirmed the greater tolerance of lucerne to zinc deficiency compared with subterranean clover (Millikan 1953b), or with alsike clover, swede, tomato, sugar beet, and oats (Hewitt, Jones, and Miles 1954). Millikan (1953b) further showed that the coefficient of utilization of zinc (i.e. dry matter produced (g)/zinc absorbed (ug)) was higher for lucerne than for subterranean clover.

In addition to lucerne, Riceman (1948) observed that *Phalaris tuberosa* growing on Laffer Sand also gave no response to zinc on areas where subterranean clover showed marked improvement in growth following zinc application. However, in tests on peat soils Anderson (1946) found that *P. tuberosa* as well as subterranean clover and white clover responded to zinc, although Yorkshire fog grass (*Holcus lanatus*) did not respond. In Western Australia Dunne and Elliott (1950) also observed that subterranean clover (Mt. Barker and Yarloop varieties) failed in the absence of zinc, whereas drooping flowered clover (*Trifolium cernuum*), suckling clover (*T. dubium*) and Wimmera rye grass (*Lolium rigidum*) made excellent growth. It was suggested that the latter three species had a lower zinc requirement than subterranean clover, but the difference could be due to the three species having a greater capacity to extract zinc from the soil.

Differences in the comparative effects of zinc deficiency on varieties of subterranean clover growing in water cultures have been recorded by Millikan (1953a).

Some observations on the relative susceptibility to zinc deficiency of cereals as compared with other plants, have been made. In a water culture experiment Millikan (1942) obtained an indication that the requirement of flax for zinc was greater than that of wheat, while Teakle and Morgan (1943) concluded as a result of field experiments that subterranean clover may be a better indicator of zinc deficiency than cereals. In a sand culture experiment Hewitt and Jones (1951) found that zinc deficiency affected various species in the following order of increasing yield depression: alsike clover, swede, tomato, sugar beet, and oats. Of these species tomato and sugar beet were considered the best visual indicators of the deficiency. As a result of field observations in Western Australia, Toms (1958a) considered that oats was much more susceptible to zinc deficiency than was wheat or barley.

Viets, Boawn, and Crawford (1954) have classified numerous plant species for degree of sensitivity to zinc deficiency, based on the severity of symptoms and on response to zinc treatment when grown on soils low in available zinc. They include cereals in their insensitive class.

Rogers, Gall, and Barnette (1939) and Camp (1953) observed that maize suffered severely from zinc deficiency and had a comparatively low zinc content when grown continuously on certain soils, whereas weeds had a high zinc content. The maize could only be grown satis-

factorily every second or third year, and then only when alternated with the weeds.

Three species of cotton showed differences in the degree of dwarfing caused by zinc deficiency in sand cultures by Brown and Wilson (1952). They attributed these differences to varying rates of auxin production or a different sensitivity to the same level of zinc deficiency. It is known that zinc is concerned in the production of auxin by plants (Nason, Kaplan, and Colowick 1950).

Watson (1950) determined the zinc content of various tissues of four apple varieties and concluded that no consistent differences in zinc status existed between them. Differences in the reactions of apple varieties to zinc deficiency were observed by Gavrilovic (1956), who also stated that apple and cherry were more affected by the disorder than plum, peach or quince.

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THE UNIVERSITY OF SYDNEY

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Sydney,
November, 1961.

M. A. Telfer,
Registrar.

Report on

FARM MANAGEMENT CLUBS AND PRIVATE CONSULTANTS

to the Council of the Australian Institute of Agricultural Science

INTRODUCTION

Terms of Reference

The terms of reference were: "To report to Council on the extension activities of farm management clubs and private consultants" (Item 10, Minutes 173rd Council Meeting, A.I.A.S., March 29, 1960).

This report goes beyond the limits of a strict interpretation of these terms of reference by inclusion of implications, evaluation, and recommendations. These may help to make the facts more meaningful to Council.

New Developments in the Agricultural Profession

Probably the most important single event in recent years in the profession of agriculture in Australia is the development of private practice in extension. Although this development is in its infancy, there are unmistakable signs of rapid and continuing growth. Moreover, we see a need for personnel in institutions of government, semi-government, and private enterprises, which have long been concerned with and responsible for extension, to reconsider and possibly to revise their activities in the light of this development. It is the major purpose of this report to present data and ideas which may assist Council to formulate a wise policy to deal with some of the problems bound to arise from the newly emerging private practice in a field which impinges so directly on Departments of Agriculture and affects so many members of the Australian Institute of Agricultural Science.

The General Position in Australia

The distribution of farm management clubs at the date of this report is shown in Table I.

TABLE I.

The distribution of Farm Management Clubs in Australia

Advisory Service	No. of Advisers		Date of Formation
New South Wales—			
Bombala	1		1955
Wagga Wagga	2		1959
Western Australia—			
Brunswick	1		1958
Quairading	1		1961
Pinjarra	1		1961
Margaret River	1		1961
Manjimup	1		1961
Wongan Hills	1		1961
Merridin	1	Appointments Pending	1961
Busselton	1		1961
Donnybrook	1		1961
Moora	1		1961
Brunswick	1		1961

The two advisers with the Wagga group are the only graduates in Agricultural Science employed so far. The adviser at Bombala is a diplomate of Hawkesbury Agricultural College and the remainder hold the Diploma in Agriculture or the Diploma in Valuation and Farm Management, or both, from one of the New Zealand University Schools of Agriculture (Lincoln College).

In New South Wales attempts have been made to form advisory services at Armidale,

Uralla, Moree, Moss Vale and Tumbarumba. The first four were unsuccessful, while the fifth still requires the support of more farmers to establish a service. In South Australia four separate groups of farmers and in Western Australia six groups are known to be currently considering the formation of clubs.

The situation with regard to agricultural consultants in private practice is not so clear however, since the term itself defies exact definition and the Committee found no satisfactory means of tracing all those who were so engaged.

PART I. EMERGING PRIVATE PRACTICES IN THE AGRICULTURAL PROFESSION

Organisation of Private Agricultural Extension Services in Australia

At present these services are limited to farm management clubs and consultant services.

Farm management clubs are organisations consisting of 35 or more farmers who employ an adviser to help them with the planning and operation of their farms. They are usually legally incorporated. The advisers are called upon to advise up to about 50 farmers each; one of the clubs at the present time is double-sized and employs two advisers. Salaries and all expenses are paid by the members on a basis agreed upon by each farmer on becoming a member of the club. In Western Australia these clubs are known as Farm Management Advisory Services, and all are members of the Federation of Farm Management Advisory Services of W.A. (Inc.).

Consultant services, as already indicated, are not so easily defined. The Committee found a wide variation in the services provided, in the forms of organisation, and in the qualifications of the personnel.

In some cases the services are provided by individuals in private practice, in some by a group of specialists operating in partnership, and in others by the employees of firms servicing agriculture. Of the latter, one company provides farm management advice for a fee as an extension of an accounting service, and others give free advice on such subjects as pasture improvement to promote business goodwill or the use of their products or services. Others again provide advisory and "trouble-shooting" services to promote the use of their products.

Individuals and partnerships provide either general technical advice, with or without advice on farm management, or specialise within a restricted field. Even in the former case they tend to specialise according to their personal inclinations.

The services are not restricted to the farming community. In addition to farmers, general practitioners advise a wide range of clients. In some cases the specialists restrict their activities to advising organisations servicing farmers, and others, graduates in agricultural science, operate outside farming in such fields as landscape gardening, and the growing of lawns and golfing greens.

The proportion of working time devoted to extension by consultants varies greatly. On the one hand some are engaged full time, while at the other extreme, professional men give advice for a fee as a spare-time activity. Few consultants do not engage in research of one form or another, and several provide special services in association with their advisory work, such as soil testing and worm counting. Several prepare extension literature for private firms, and others are retained by country newspapers and journals to contribute regular articles.

Some consultants confine their activities within fairly restricted areas of their home States, and others travel widely. In one case a private consultant ranged as far as Fiji, and another had been to New Caledonia. The Committee learnt of consultants based in all States except Queensland and Tasmania, as well as in Papua and New Guinea.

The qualifications of consultants vary from those of university professors to people with little more than a glib tongue. Although the number of well-qualified consultants has been growing since the first consultants entered the field about 1957, it is evident that many with doubtful qualifications have been re-

ceiving payment for their services for some time.

Payment for services is normally on either a fee or retainer basis. Qualified men—the only ones from whom details were received—appear to command quite adequate retainers in relation to the work performed. Fees charged are largely on a time basis. Clients struggling to make ends meet are often charged little or nothing at all, with a view to fees at a later date when they start to make worthwhile profits. Owners of the larger properties are charged more than those on smaller holdings.

Private Practice Overseas

There is no attempt here to make an exhaustive survey of the position overseas. It is in fact virtually impossible to obtain a comprehensive picture of private practice in other countries. Consequently this section constitutes mere snippets of information, which may perhaps enable Council to see the development in Australia against a wider background.

New Zealand. The farm club movement in New Zealand descends directly from the Lincoln College Farm Advisory Service, which began about 1935. However, the first clubs there did not become established until the late 1940's. The farm clubs in Australia are modelled on those of New Zealand and are constitutionally similar. In 1960, there were 18 clubs with 23 advisers and at least three full-time, self-employed consultants.

Britain. In 1956, there was formed the British Association of Consultants in Agriculture and Horticulture. This was set up by a "small but steadily increasing band of consultants in private practice . . . that would . . . also offer the public some standard of competence for their protection."

Canada. The Agricultural Institute of Canada is similar to the Australian Institute of Agricultural Science. In nearly all Provinces (States) there is also an Institute of Agrologists. These are formally organised bodies established under Acts of provincial legislatures. Membership of Agrologists' Institutes and the A.I.C. is reciprocal. The Institutes were formed to undertake activities which were not legally possible by the A.I.C. The objectives are as follows:

"(a) The according of legal recognition and status to professional agricultural scientists.

(b) Power to require standards of education and ethics from professional agricultural scientists.

(c) Power to control the type and validity of information provided to farmers by professional agricultural scientists."

United States of America. One of the major developments in farm management has been the formation of associations of farmers for the employment of a fieldman to assist them in accounting, in analysing their business operations, and in planning improvements in the organisation and operation of their farms. Some details of the type of service which these associations try to provide are given by Case and Williams in "Fifty Years of Farm Management":

"The general purpose . . . shall be to encourage farmers . . . to keep records and maintain an accurate system of farm accounts through written records and otherwise to submit such records for research, teaching and extension purposes to the Department of Agriculture of the University . . . towards the end, that those principles of management, organisation and operations contributing to successful farming may be examined, studied and made known to the members . . . and others, thereby serving a public need . . .

To effect the foregoing, the plan of operation shall be to make available to farmers in the area . . . at a charge to defray expenses, a farm account service, aimed to assist the co-operating farmers:

1. To secure facts about their particular farms.

2. To study their farming enterprises through comparison with other farms of like size and type, and

3. To improve, and organise their business procedures to meet changing conditions.

The specific services to be provided to farmers are:

(a) Visits or conferences with each co-operator by the fieldman.

(b) Farm and home account books as required for a complete record of the farm business and the personal and household expenditures.

(c) Weekly farm management and outlook information.

(d) A summary and analysis at the end of the year, of each co-operator's records; assistance in the

development of a long-time farm plan; and assistance with income tax records and returns."

From the foregoing it is clear that private professional practice in agriculture is common to many countries, and that in some, legal protection is given to the public and to practitioners by legislation similar to that dealing with certain other professions in Australia.

Terms and Conditions of Employment and Consultation

Advertisements for advisers and consultants indicate that farmers and other employers have a strong preference for University graduates. Despite this, many non-graduates have been appointed for reasons which will be considered later in this report.

Salaries offered are competitive with those in State Departments of Agriculture. That is, they are higher by £250 to £500 per annum. In 1960, a consultant's position was advertised at £2,000-£2,500-£3,000 and an adviser's at £2,000-£2,750. In 1961, several advisory positions were advertised at £1,900-£2,750. In addition to these salaries, employers provide superannuation, commonly on an F.S.S.U. basis but not quite as generous to the adviser. Usually he contributes 5 per cent of his salary and the employer an additional 5 per cent. Incomes of established self-employed consultants are thought to be from £3,000 to £4,000. The starting salaries of new graduates in Departments of Agriculture are in the region of £1,300 to £1,400 with career ranges of £1,600 to £1,900 in six to eight years.

Holidays and leave are similar to those in the State Civil Services or in Companies. Hours of work are probably longer. Salaries of advisers and of employed consultants are net of travelling and mileage expenses. They are usually required to have their own cars, though some groups of farmers will finance an adviser into his own car, and at least two groups own houses rented by their advisers. The initial term of employment in groups is the same as in a private firm, with a minimum initial term of three years if service is satisfactory. This is often confused with the farmer's three-year term of contract entered into when he joins a club. Clubs are operated by elected farmer members. The adviser is usually required to sign a statement of acceptance of written conditions and duties of employment. Duties are to advise only club members—to visit them about six times per year, to organise and run discussion groups and field days, etc.

Fees are usually charged to farmers on the basis of effective farm area and are levied to cover costs. Trading activities are not undertaken by Western Australian clubs. In New South Wales both clubs undertake bulk and co-operative buying to obtain discounts for members. Secretarial assistance, usually part-time, is also available to advisers at the farmer members' expense. Consultants who set up on their own account may also undertake veterinary, book-keeping, and trading services on behalf of their clients.

The private practices which are the subject of this report have not yet had time to settle down and become regularized and uniform. Consequently, details of terms and conditions of work are not easy to obtain. Nevertheless, the foregoing picture is accurate as far as it goes. The outcome of a situation in which an adviser and the farmer members of a club "fall out" is not known to us, and this and other situations can be learned about only after the lapse of further time.

Likely Development in Private Advisory Services

We are of the considered opinion that there is a large and growing demand among farmers and others for the expert services of agricultural advisers and consultants in private practice. In support of this opinion, there are the following points:

1. The increasing awareness among farmers of the growing difficulty of and need for keeping up with scientific and technical advances in agriculture within limits imposed by costs, prices, and farm-firm resources. The willingness, almost eagerness, of farm industries to levy their members to provide funds for research may develop into efforts towards the improvement of getting the results of this research more widely known and put into practice. This increasing awareness among

farmers is due to a number of factors, some of which are presented here:

(a) The cost-price squeeze; continually rising costs of materials and labour, and falling and uncertain markets are forcing the farmer to consider methods of increasing his efficiency.

(b) Scientific and technical advances are increasingly complex, are emerging at an increasing rate, and involve large amounts of capital.

(c) The capital, income, expenditure, and taxation of the individual farm firm have now reached large-scale proportions for what is still a single-owner-operated business.

(d) The post-war development of city business men interesting themselves in farm property.

(e) The post-war establishment of Agricultural Economics and Farm Management as subjects of study within the Australian Universities and some Departments of Agriculture. This has helped to make farmers, extension officers, and agricultural scientists aware, at least of the existence, of principles of economic and business decision-making.

(f) The achievements of agricultural scientists and technicians, and the increasing attention being paid by executives of companies and in governments, to business management and administration have probably helped persons concerned with farming and grazing to become more receptive to advice and consultation.

2. The unlikelihood of Departments of Agriculture being provided with resources sufficient to permit them to move from mass extension to personal advice and consultation. Put in another way, Departments are unlikely to be permitted to increase their extension officer-to-farmer ratio from 1:400-1000 to the adviser-farmer ratio of 1:50.

3. The establishment of so many advisers and consultants in private practice, particularly in Western Australia and New South Wales, in such a short time, together with the reports to this Committee from advisers and consultants that interest in their services by farmers is awakening and quickening.

On the other hand, the Committee agrees that Government extension services will always have to play a large part in direct extension work. Also, one might question how far private services would continue to thrive under extreme economic conditions of boom or depression. The evidence from the United States suggests that both clubs and consultants should ride out such conditions with little difficulty. For example, the first club was formed in Illinois in 1924. By 1950, when the first 25 years of its existence was being celebrated, it was found that 45 members out of the 235 at that time were foundation members and had remained with the club throughout the depression years as well as the boom conditions of the 1940's.

Evaluation of Clubs and Consultants

In view of the increasing popularity of these services it seems appropriate to consider how well they are likely to meet the needs of farmers and whether they can provide professional men with satisfying careers.

Farm management clubs. From the point of view of a farmer member, a club is able to provide comprehensive, up-to-date, continuing advice on a close personal basis such as is beyond the capacity of State Departments of Agriculture. At the same time, he has assistance ready to hand in defining and solving his problems, and a quick means, through his adviser, of having those problems handed on for solution to the appropriate research authorities where necessary. He also benefits from being a member of a small corporate body, enabling him to enjoy greater discussion, mutual instruction, and a widening of experience beyond his own property.

He also enjoys special services which can only occur in a closely knit organisation. Co-ordination of farm accounting and recording systems among the members, for example, provides a useful basis for the comparison and evaluation of physical and financial achievements. All clubs in Western Australia have initiated their services by conducting surveys of members' farm resources, practices, and performances, and have distributed the findings in anonymous tabular form to their members. This initial survey and continuing annual surveys have provided a useful basis for the measurement of efficiency, the construction of

models and, in a few instances, for the application of linear programming, leading to the preparation and execution of individual farm plans and budgets.

The practice of bulk buying on the part of the two New South Wales clubs has been held by some to be a further advantage of the organisation. Although it might have some value when used with discretion (for example, to promote pasture improvement by obtaining discounts on fertilizer, seeds, and certain items of equipment), this Committee feels that it should be avoided as it tends to compromise advisers and to divert the club from its main objective. Bulk buying is not a function of the clubs in Western Australia.

From the adviser's point of view, the job has both advantages and disadvantages. There can be little doubt that the work itself could be particularly satisfying. The opportunity of advising a restricted group of farmers; of being able to know each farm and its owner really well; of drawing up plans for each farm and seeing them through the various stages of implementation; and above all, of advising men who are enthusiasts, has obvious appeal. Pay better than that offered by State Governments and independence of national policy considerations are further important inducements.

On the other hand, there is a certain amount of real or apparent insecurity. All appointments made so far have been on a basis of a three-year contract in the first instance. However, the Committee is aware of only one case of refusal of a club to renew a contract. This was in New Zealand where a club disbanded.

Also, the work makes heavy demands on the adviser's time although provisions regarding working hours (40 per week) are made in contracts drawn up in Western Australia. Provision is usually made also for annual and sick leave.

A matter for consideration is that advisers do not appear to have been indemnified against legal action as a result of the advice they have given. Again, the Committee does not know of any case where an adviser has been sued, but the risk may exist.

Consultants provide a different type of service. Where they are paid on a retainer basis for regular visits and are close enough to answer calls at short notice, some of the features of clubs would apply.

Many farmers do not want continuing advice. They prefer to maintain what they see as their independence and they feel that membership of a club would involve some sacrifice of freedom. Others would like to join a club, but cannot, either because they are unable to raise sufficient local enthusiasm to form one, or because membership of the local club is closed.

Often the local adviser of the Department of Agriculture is unable to provide help when it is wanted, and in any case cannot devote sufficient time to give fullest consideration to the problem and to draw up plans and budgets. Furthermore, he often does not possess the requisite skills. The only answer is to call in a consultant.

From their point of view, consultants enjoy complete freedom in the work they undertake and the methods they adopt to tackle farmers' problems. They undertake a wide variety of work, often travel widely, and obtain wide experience in a comparatively short time.

Setting up a consultant service, particularly for independent private practitioners, obviously involves some risk. A would-be consultant must have some experience beyond his academic training before setting up, and therefore must be prepared to sacrifice a secure job, and often the accrued benefits of a pension fund, for the less certain prospects of self-employment and an unsubsidised old age. However, the Committee has not heard of a case where a consultant has been forced to withdraw through lack of demand for his services.

In general, it may be said that these services introduce the new and important principle of farmers paying for detailed individual attention to their problems. The operation of these services is likely to promote the welfare of the nation as well as that of the individual farmer.

The Supply of Advisers and Consultants

The supply of agricultural scientists qualified to perform the function of club advisers and

consultants in farm management is severely limited. Evidence of this shortage of supply is the need for second advertisements calling for applications, the small number who do apply, and their generally low quality.

The reasons for this situation are probably to be sought in the history of the profession which developed under government sponsorship. But whatever they are, they are important to the Council of the A.I.A.S.

Consultants in specialist fields have not, so far, come forth in great numbers either, and though we recognise that the consultant movement has only been under way for four years or so, most of the reasons set out below for poor responses to advertisements for club advisers would probably apply equally well to potential consultants in all fields.

We submit that salaries and conditions of work are not important reasons for the failure to call forth a supply of suitable persons prepared to enter private practice. We offer the following explanations:

1. The fact that private practice is not extensive in Australian professional agriculture operates against its becoming established rapidly. The idea is new. Most graduates, and even most students now in the University Faculties of Agriculture, probably expected that their career would be in either C.S.I.R.O., a firm servicing agriculture, or a State Department of Agriculture. This expectation was probably formed one to two years before entering University. Most agricultural scientists, therefore, are probably "organisation" minded. Perhaps, if contemplated at all, it appears to them that to enter the unknown and unestablished field of private practice is to give away security and promotion in lieu of more salary, more independence and more uncertainty. We do not consider it likely that many persons will leave their employment in Government organisations for private practice. As private practice develops, however, we expect that it will be staffed by newer graduates, probably after a period of training in a government department, and that in time, attitudes of professional agricultural scientists towards private practice will be similar to that of doctors and lawyers to theirs. It is likely, too, that where a single-adviser club expands to two or three advisers, a new graduate will be employed in the first instance as a trainee.

2. Another deterrent to agricultural scientists may be dislike of a committee of farmers as employers. This is a permanent difficulty which may be overcome in time by farmers' clubs federating as they already have done in Western Australia, and the federation being the employer. A precedent exists for this in Western Australia, where teachers are employed by a Kindergarten Union to work at a kindergarten under its local management.

3. Related to 1 and 2 above is the question of status and prestige. The status of the agricultural profession *vis-a-vis* that of other professions (as distinct from the status of some individual agricultural scientists) is widely agreed to be pretty low. Moreover, such prestige as there is appears to be associated with, and perhaps to have been appropriated by, the government departments of C.S.I.R.O. and Agriculture. In private practice, it tends to be associated with individuals rather than with group or institutional competence. To achieve prestige in agriculture through private practice is probably exceedingly difficult and it may be another factor keeping low the supply of agricultural scientists available for private practice.

PART II. IMPLICATIONS FOR THE A.I.A.S. AND OTHER INSTITUTIONS

The emergence and development of widespread private professional practice in agriculture are a matter of prime concern to the A.I.A.S. This concern we find to be in three distinct though related areas. These are the opportunities for employment, the status of the profession, and the effects on existing institutions.

Opportunities for Employment

According to the A.I.A.S. Report on Agricultural Scientists in Australia made in 1959, almost 80 per cent of the agricultural scientists are employed in Government organisations and Universities and only one per cent is self-employed. It is submitted that this preponderance of employment in government services and, conversely, the virtual non-existence of private practice in the profession, are caus-

ally related to the salary structure of agricultural scientists bearing an unfavourable comparison with the ruling rates of pay in other professions. At the same time, the demand for private services has been forthcoming only recently. We are of the strong opinion that private professional practice in agriculture constitutes not only another worthwhile employment opportunity for agricultural scientists, but as an alternative avenue of employment is an influence which, as it develops, will operate towards higher salaries in government departments.

Professional Status and Qualifications

There is no doubt that status and prestige bear a close relationship to salary and conditions of work. Also, they are related to professional qualification. From the A.I.A.S. point of view, it is important that private practitioners in agriculture should be suitably qualified.

It may be argued that unless private practitioners are well qualified, private practice work will be at a low level, unattractive to better-qualified agricultural scientists and therefore will not constitute an alternative avenue of employment for the profession as a whole. There may be truth in this, but against this point is the question whether second-rate services will be long tolerated by farmers who in private practice will become direct employers. As such, farmers will "hire and fire," and it is unlikely that they will put up with second-rate private advisory services, particularly where State extension services are well known and well regarded. However, it probably is in the interests of the A.I.A.S. and of farmers to admit only suitably qualified people into private practice. In this connection, some facets of Western Australian experience appear to be worth mentioning.

All positions in Western Australia were advertised in the manner used by this State's Department of Agriculture. Of the six appointments made in private practice in the last two years, five went to New Zealand diplomates and one to an Australian University graduate. The following points emerge:

1. The quality of graduate applicants (personality, experience and training) for this type of work appears to be inferior.

2. The number of graduate applicants is small. Reasons for this have been advanced under the heading: The Supply of Advisers and Consultants, above.

3. New Zealand diplomates generally have a better training for this type of work than Australian diplomates:

(a) New Zealand diplomas are probably of a higher standard than those given in Australian Agricultural Colleges. Training for them is given within the New Zealand University Schools of Agriculture.

(b) There is a course for diploma or degree holders leading to the Diploma of Valuation and Farm Management. This course is more specifically tailored to the needs of Farm Management advisers than are most University degree courses in Australia.

Farmers in Western Australia have generally been faced with the alternative of appointing a New Zealand diplomate or of not making an appointment at all.

We do not consider that the formal qualifications of either the present degree holders or of New Zealand diplomates are particularly well suited to the needs of private practitioner work in agriculture.

Effects on Existing Institutions

Private practice in agriculture could, in the long run (10 to 20 years), make considerable impact upon State Departments of Agriculture. As advisory and consulting services develop, more and more farmers will need to rely less heavily and less directly on the States' extension services. It appears to be well within the bounds of reason to visualise State extension officers dealing more with private advisers and less with farmers. This could result in two changes. One is an improvement in status in the local community of the Departmental extension officer, who would then extend to fewer farmers directly and more to advisers and consultants. Secondly, if these services become widespread, there might be a change in the emphasis of the Departments' work. Perhaps there would be less emphasis on extension and more on certain types of research. On the other hand, the extension officer of the Department of Agriculture may, with fewer

farmers requiring his services, develop work similar to that of the club advisers.

PART III. CONCLUSIONS AND RECOMMENDATIONS TO COUNCIL OF A.I.A.S.

We have come to the following conclusions:

1. Private practice in professional agriculture in Australia is beginning to develop and in due course is likely to become a major avenue of employment for agricultural scientists.

2. There is a large demand for advisory and consultant services which is in considerable excess of the supply of practitioners.

3. With possibly one or two exceptions, University and College courses in Australia are not particularly well suited to the requirements of private professional practice in agriculture.

4. Terms and conditions of employment in private practice appear to be reasonable and attractive. The lag in supply of practitioners we attribute to "organisation-mindedness" of graduates and to uncertainties at being among the first to set up in private practice.

5. Existence of strong private practice in professional agriculture would constitute a new alternative avenue of employment, would constitute indirect upward pressure on departmental salaries, and would serve to improve the status of the agricultural profession.

6. In the long run (10 to 20 years), we expect private practice to become strong and widespread and to further influence State Departments of Agriculture in two ways; firstly, to extend directly to fewer farmers and to more advisers, and, secondly, to tend to undertake less extension and more research.

If these conclusions are accepted, then we submit that the following recommendations are relevant for consideration by the Council of A.I.A.S. Underlying these recommendations is the firm belief that the development of private professional practice in Australian agriculture will proceed apace and that it is in the interests of farmers and professional agricultural scientists for the A.I.A.S. to actively assist in its development.

We recommend:

1. That the A.I.A.S. seek to have set up in each State a Board of Registration of legally acceptable agricultural advisers and agricultural consultants. This would require State legislation, compilation of a register, statement of conditions and qualifications for registration, and so on. Perhaps Council could recommend each Branch to set up a Sub-Committee to examine existing legislation and possibly to draft legislation for agriculture acceptable in each State, in line with that dealing with other professions protected by law.

2. That the A.I.A.S. encourage young men to undertake University courses in Agriculture with a view to private practice. In this connection we consider that members of Council especially should guard against possible bias. It is a natural tendency to bring to the A.I.A.S. the viewpoint of one's own organisation, and it may appear that in the short run the interests of Departments of Agriculture conflict with those of private practice. Although we do not subscribe to this, we consider it important that Council should develop its own attitude and outlook and not merely reflect those of other organisations. We do not agree with the A.I.A.S. Report on Agricultural Scientists where it states that "opportunities in the profession as a whole will depend largely on the nature and the number of positions for agricultural scientists provided in the government services". We recommend that Council act upon its public declaration that the "A.I.A.S. will work to find new opportunities for agricultural scientists . . ." Here again, ways and means will differ in each State. Perhaps each Branch could have a Standing Sub-Committee working on this continuously.

3. That the A.I.A.S. request Professors of Agriculture to re-examine their courses from the point of view of their suitability for extension and advisory work in agriculture.

4. That Council give favourable consideration to the publication of a booklet dealing with

the establishment and operation of farm clubs. It is envisaged that such a booklet could play an important part in creating and widening the effective demand for the services of professional agricultural scientists throughout Australia. In this connection, Council may like to consider associating itself (through the W.A. Branch) with a "Guide to Farmers" already in the course of preparation by the Federation of Farm Management Advisory Services of Western Australia (Inc.).

These recommendations cover the regulation of quality of practitioners and the encouragement of their supply for private practice. Between them they would enable the A.I.A.S. to stand in relation to private practice in its field much as we think the B.M.A. stands in relation to its private practice field.

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Letters

Phosphorus and Symbiotic Nitrogen Fixation in Subterranean Clover

The importance of phosphorus in symbiotic nitrogen fixation was first demonstrated by Truesdell (1917), who showed that phosphate increased the dry weight and the per cent nitrogen of lucerne plants. However, as Fred, Baldwin and McCoy (1932) indicate, these results were not always obtained in subsequent work. For subterranean clover, Trumble and Shapter (1937) showed increases in plant yield, and in the total nitrogen yield of the plants, with increasing phosphate dressings. The per cent nitrogen in the clover plants, however, was reduced by the phosphate treatment and, consequently, it was not possible to determine whether phosphate had influenced nitrogen fixation.

In a recent experiment, phosphorus and sulphur were applied in July to mixed pastures growing on a wide range of soils on the Southern Tablelands of New South Wales. The pastures had received very different total amounts of superphosphate in previous years, and in each case the legume component of the pasture was subterranean clover *(Trifolium subterraneum* L.). Mono-calcium phosphate was applied at levels such that the phosphorus in them was equivalent to the phosphorus in superphosphate at rates of 0, ½, 2 and 4 cwt per acre. Calcium sulphate was applied at the rate of 0, ¼, 1 and 2 cwt per acre. A basal dressing of sodium molybdate at the rate of 2 oz per acre was used on all soils. The factorial design was replicated twice on each soil. The plants were harvested at maturity.

In this experiment the linear trend due to treatment with phosphorus, averaged over all levels of sulphur, has been used to determine the response to phosphorus on these soils. The level of significance indicated in the accompanying table is that of the linear trend due to treatment with phosphorus.

Eight of the eighteen soils tested in this experiment responded to phosphorus. The effect of phosphorus treatment on total pasture yield, and on the yield, per cent nitrogen, and nitrogen yield of clover on these soils, is shown in Table I. The trend values for the control treatment and for the treatment which gave the greatest response to added phosphorus are indicated in absolute terms. In addition, the increase due to treatment with phosphorus has been expressed as a percentage of the control value.

TABLE 1

Effect of phosphorus on the yield and nitrogen content of pasture.

Soil	Total yield			Clover yield			Clover nitrogen			Clover nitrogen		
	cwt/acre		Percentage	cwt/acre		Percentage	%		Percentage	lb/acre		Percentage
	Control	+ P	increase	Control	+ P	increase	Control	+ P	increase	Control	+ P	increase
1	18.2	33.8	85.7‡	10.4	32.1	208.6‡	2.55	2.99	17.3†	29.4	100.6	242.2‡
2	35.0	48.4	38.3†	22.5	28.1	24.9*	2.76	2.99	8.3*	66.4	97.1	46.2†
3	41.0	47.6	22.7*	16.9	21.2	25.4	2.54	2.91	14.6†	46.8	64.2	37.2
4	37.1	46.7	25.9†	21.1	22.8	8.1	2.63	2.92	11.0*	61.0	71.5	17.2
5	54.4	62.1	14.1*	45.3	57.4	26.7†	2.20	2.74	24.5‡	113.3	172.9	52.6‡
6	26.2	44.0	67.9‡	20.0	38.6	93.0‡	2.40	2.58	7.5	59.5	106.9	79.7†
7	17.2	37.6	118.6‡	7.0	28.1	301.4‡	2.18	2.34	7.3*	13.6	78.0	437.5‡
8	32.2	41.0	27.3	18.9	20.0	5.8	2.47	2.85	15.4†	52.1	62.1	19.2
9	55.7	63.6	14.2*	51.8	55.8	7.7	2.70	2.86	5.9*	156.8	179.5	14.5

* Probability < 0.05 † Probability < 0.01 ‡ Probability < 0.001

Table I shows that treatment with phosphorus increased the yield of clover, the per cent nitrogen in the clover, and the yield of clover nitrogen on soils 1, 2, 5 and 7. When phosphorus response was measured in terms of the linear trend, no relationship between per cent soil nitrogen and the phosphorus response in clover yield on the eighteen soils was found. However, a negative relationship ($b = -6.166$; $P<0.05$) between per cent soil nitrogen and the phosphorus response in per cent nitrogen in the clover was obtained. These results show that phosphorus is involved in the symbiotic nitrogen fixation complex in subterranean clover.

All the significant effects of phosphorus on the per cent nitrogen in the clover for the eighteen soils tested have been listed in Table I. On soils 3, 4 and 9, phosphorus increased the per cent nitrogen in clover without affecting clover yield. These soils, on the basis of total pasture yield, were found deficient in phosphorus. On soil 8, phosphorus also increased the per cent nitrogen in clover without affecting its yield. While the 27 per cent increase in total yield due to treatment with phosphorus failed to gain significance on this soil, there can be little doubt the effect was real. This evidence suggests that the phosphorus effect on the per cent nitrogen in clover only occurred on phosphorus deficient soils and that the effect was measurable before the phosphorus deficiency became limiting for clover yield. The change in per cent nitrogen in clover due to treatment with phosphorus would appear to be a more sensitive measure of incipient phosphorus deficiency than clover yield.

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Chemical Control of Leafy Bossea

The effectiveness of a number of weedicides, applied as foliage sprays, in reducing the density of Bossiaea *was tested. Of the weedicides used, the most successful was 2,4,5-T applied at a rate of 2.5 or 5.0 lb per acre.*

The protection afforded young seedlings by the dead Bossiaea *stems assists the development of the herbaceous community.*

Leafy bossea (*Bossiaea foliosa* A. Cunn.) a healthy shrub 3-4 feet in height, is widespread in montane and subalpine environments of south-eastern Australia (Costin 1954, 1957). Although very combustible, its regeneration is favoured by fire compared with that of other associated species. Consequently, areas which have been frequently burnt are often characterized by dense *Bossiaea* heaths. Such areas present a considerable fire hazard, and from a catchment management viewpoint are also less desirable than a dense herbaceous cover (Costin *et al.* 1959).

Clearing and burning associated with transmission line development have led to similar problems, as in the Snowy Mountains and Kiewa areas.

In these environments pyric *Bossiaea* heath, if undisturbed, gradually thins out and herbaceous vegetation re-establishes itself. However, this is a slow process reckoned in terms of about 50 years (Costin *et al.* 1959). If secondary succession could be hastened, fire

protection and catchment performance would be correspondingly improved.

The following experiments were carried out to investigate the possible role of chemicals to hasten this succession.

Methods

The experiments were located in the Daners Creek-Pipers Creek area of the Snowy Mountains region of southern New South Wales, at an elevation of approximately 5,200 feet. Although the density of the *Bossiaea* varied slightly within the experiments, the height of the plants (about 3 feet) was uniform. Plots were 10 x 25 links (1/400 acre) and treatments were applied on November 21, 1958; February 3, 1959; April 8, 1959; and December 9, 1959. The experimental design for the first three applications was a randomized block with two replications, and for the fourth application a randomized block with three replications.

The chemicals used were the butoxyethanol ester of 2,4,5-trichlorophenoxy acetic acid (2,4,5-T); a mixture of the butoxyethanol esters of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in the proportion 2 : 1; and AMS (ammonium sulphamate) with and without a commercial liquid detergent ("Comprox — a C.O.R. product). All were applied in aqueous solution or emulsion as foliage sprays at a rate equivalent to 100 gal per acre, using a two gallon pneumatic hand spray operating at a pressure of 30 lb per square inch. Rates of application are shown in Table I.

An estimate of the percentage ground cover of *Bossiaea* was made for each plot prior to treatment, and again on March 10, 1961 — an interval ranging from 15 months for the December 1959 treatments, to 28 months for the November 1958 treatments.

Measurements of the herb + snow grass cover and of *Bossiaea* regrowth were also taken

TABLE 1

Mean percentage ground cover of Bossiaea foliosa *before and after treatment, and mean percentage ground cover of snowgrass and herbs after treatment.*

Treatment dates			Treatment						
			Control	2,4,5-T (lb/acre)			2,4,5-T + 2,4-D (lb/acre)		
				1.25	2.5	5.0	1.25	2.5	5.0
21.xi.58	Living *Bossiaea*	21.xi.58	87.5		85.0	92.5		77.5	70.0
	Living *Bossiaea*	10.iii.61	81.0		0.0	0.0		1.9	0.0
	Regrowth*	10.iii.61	16.0		0.2	0.2		0.6	0.4
	Snowgrass and herbs	10.iii.61	10.4		31.7	41.4		35.2	53.1
3.ii.59	Living *Bossiaea*	3.ii.59	72.5		80.0	75.0		80.0	72.5
	Living *Bossiaea*	10.iii.61	67.25		4.25	3.5		4.0	1.6
	Regrowth*	10.iii.61	3.7		1.9	0.4		1.9	0.8
	Snowgrass and herbs	10.iii.61	48.8		53.9	38.1		32.2	47.7
8.iv.59	Living *Bossiaea*	8.iv,59	85.0	85.0	75.0		72.5	80.0	
	Living *Bossiaea*	10.iii.61	78.6	8.5	3.75		47.25	24.5	
	Regrowth*	10.iii.61	3.5	2.4	Trace		8.6	4.3	
	Snowgrass and herbs	10.iii.61	40.2	46.1	50.75		57.0	36.3	
9.xii.59	Living *Bossiaea*	9.xii.59	95.0	86.7	90.0	88.3	88.3	96.7	90.0
	Living *Bossiaea*	10.iii.61	87.0	35.2	9.0	0.3	41.7	8.8	0.3
	Regrowth*	10.iii.61	4.2	1.0	0.5	0.0	1.1	0.4	Trace
	Snowgrass and herbs	10.iii.61	34.2	43.1	52.9	44.5	35.9	48.4	46.6

* Regrowth from base of plant, not from treated stems.

on March 10, 1961, using eight random quadrats of ¼ sq. metre per plot.

Results

The results are given in Table I.

Best results were obtained with 2,4,5-T, which gave effective control at all times. It would appear that the minimum effective rate of application for this chemical is of the order of 2.5 lb per acre. The mixed esters of 2,4,5-T and 2,4-D were equally effective except when applied in April 1959. At this time 2.5 lb per acre of the mixed esters reduced the ground cover of *Bossiaea* to only 24.5 per cent as compared with 1.9 per cent, 4.0 per cent and 8.8 per cent at other times of application. AMS, with or without a wetting agent, caused only slight reduction in percentage ground cover of *Bossiaea,* and shows no promise of providing effective control, even when applied at 100 lb per acre.

There was least regrowth of *Bossiaea* from the base of the plant where treatment had been most effective in killing the stems.

In general, the percentage ground cover of snow grass and herbs after treatment was highest where living *Bossiaea* had been reduced to small proportions, but the results were not consistent.

Discussion

The dense, erect growing habit and the tough, springy nature of *Bossiaea* make complete coverage of all portions of the plants rather difficult, with the result that occasional branches are missed during spraying operations. If a branch is not sprayed it remains alive, even though all other branches on the same shrub (sometimes numbering 50 to 100) are killed. This occurred with the higher rates of application of 2,4,5-T and the mixed ester applications, and it is clear that if complete foliar cover had been achieved, these treatments would all have given complete control.

These trials clearly indicate that chemical control of *Bossiaea* can be achieved by foliage sprays throughout the summer and autumn at different physiological growth stages of the plants. In November 1958, 50 per cent of the *Bossiaea* present was in flower, in February 1959, 50 per cent had seed heads present, and in December, 1959, the *Bossiaea* was in full flower. However, at low rates of application (1.25 lb per acre), 2,4,5-T was more effective when applied in April than when applied in December.

When applied in April, the mixture of 2,4,5-T and 2,4-D at 1.25 and 2.5 lb per acre appears to be less effective than 2,4,5-T alone at the same rates. These results are of interest in the light of previous work with *Eucalyptus rossii* Baker and Smith, when April applications of 2,4,5-T alone or mixed with 2,4-D were about equally effective. (Robertson 1960.)

AMS treatments, both alone and with the addition of a wetting agent, were ineffective at all times. Treatment with AMS killed the leaves, and flowering was subsequently delayed. However, the only permanent injury was death of the upper 4-6 in. of the branches. The failure of the wetting agent to increase the effectiveness of AMS is disappointing when compared with results obtained with these materials with *E. rossii* (Robertson 1960).

Regrowth appears to depend on the effectiveness of the original treatment. If the original treatment gave a good *Bossiaea* control, the percentage regrowth was low, but where the initial treatments were less effective, the regrowth was correspondingly higher. All regrowth arose either from the base of the plant or from branches that had suffered minor spray damage.

It is doubtful whether the amount of regrowth following the more effective treatments is likely to be significant. If large areas of *Bossiaea* are to be killed, it would be desirable to develop methods for hastening the succession to herbs, including snow grass, which could be expected to compete successfully with the young *Bossiaea* regrowth. The early establishment of a snow grass community in areas where the *Bossiaea* has been killed is necessary for prevention of soil erosion and for achieving optimum water yield (Costin *et al.* 1960).

The stems of the *Bossiaea* sprayed with the 2,4,5-T and mixed ester preparations gradually curve inwards towards the centre of the plant,

thus providing substantial protection from frost and wind for grass and herb seedlings. As the woody stems of the *Bossiaea* plants are resistant to decomposition, they continue to provide such protection for long periods. Dead stems of plants sprayed in November 1958 showed little sign of decomposition in March 1960.

In March 1960 it was clear that the herbs growing either in open spaces not inhabited by *Bossiaea* or in the plots where treatment had been effective were more vigorous and were producing more seed than those growing under a dense stand of *Bossiaea*. *Poa caespitosa* auct. aust. and *Stipa nivicola* J. H. Willis always appeared where treatment gave a high percentage of *Bossiaea* control.

Other species recorded, although occurring in limited quantities were *Helichrysum hookeri* (Sond.) Druce, *Hovea longifolia* sens. lat., *Cassinia aculeata* (Labill.) R.Br., *Olearia subrepanda* Hutchison, and *Pleurandropsis* species. Of these, only *C. aculeata* was killed by the 2,4,5-T.

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The Radio Program "Agricultural Digest"

For some time prior to 1958 radio broadcasts from the headquarters of the Department of Agriculture & Stock in Brisbane had been in the form of four and a half minute talks. A number of radio stations had used these talks from time to time, but in June, 1958, only four were using them regularly.

Two problems were apparent:

The first was the time taken to prepare a four and a half minute talk — often over an hour to write and edit such a broadcast; the second was the distribution of the talks. One tape took about two months to be posted from station to station and back to headquarters in Brisbane. This meant that topical material had to be avoided. Delays were not in the post but in waiting at the station to be fitted in with other material.

Development of "Agricultural Digest"

A new program was devised and first issued in December, 1958. It consisted of four one-minute items (of about 130 words) from technical officers concerned with different subject matter. The items and speakers were introduced by a compere and the broadcast was given the name of "Agricultural Digest" so that it could be programmed more easily, and so that people could remember the name. The broadcast was produced each week.

The contributors found that very little time was involved in writing one-minute items, which required no introductory paragraph. Frequently they were prepared as ideas were obtained from letters, files, and articles.

In two and a half years of broadcasting, eighty-nine officers have broadcast five hundred and thirty-two short talks. One speaker has prepared thirty-three items in this period.

The procedure used in producing the broadcast is as follows:

1. Speakers are arranged on Monday to record on Thursday. (Arrangements made during the previous week are sometimes forgotten.)
2. The four speakers are contacted on Wednesday afternoon as a reminder and as a check that it is still convenient for them.
3. Recordings are made before 10.30 a.m. on Thursdays using a high-quality omnidirectional crystal microphone and a good-quality tape recorder. A level meter is used as speakers come to the studio one at a time.
4. A second tape recorder of the same model is connected to the first tape recorder through a "mixer." This contains a suitable resistance which enables the output of the first recorder to be matched to the input of the second. Fourteen copies of the master tape are "dubbed" and checked for quality.
5. A slip of paper giving details of the broadcast includes: "not to be broadcast after ———." This ensures that material is not used when it is no longer topical. The slip is placed in the tape box and the boxes are despatched to most Queensland country radio stations on Fridays.
6. Tapes that are returned are demagnetised with a bulk eraser and used again.

Frequently the material in one item is specific for one area, but the assumption is that this is tolerable in other areas as it lasts for only one minute.

Details of a typical program, as they appear on the slip, are as follows:

Agricultural Digest, No. 141

Not to be broadcast after 26th August, 1961.
Time — 5 min. 34 sec.

(1) Dr. A. Brimblecombe — Protection of Buildings from White Ants.
(2) J. Ladewig—Checking Soil Conservation Waterways.
(3) T. Abell — Feeding Molasses to Pigs.
(4) R. Noakes — Weeds in Lucerne Hay and Chaff.

In September, 1959, an evaluation of this program was carried out among radio stations on the mailing list. The questionnaire contained questions on the material, the quality of the reproduction, and the frequency of the broadcasts. There was general agreement that the programs were suitable and of adequate quality. The scheme has been continued and recently two more radio stations have asked for "Agricultural Digest."

Discussion

The study by Emery and Oeser (1958)* showed that many farmers listened to the radio because it gave them a feeling of being part of a wide community. "Agricultural Digest" with its diverse subject matter aims at doing this. By discussing the problems of primary producers throughout the State it strives to attain in agriculture the flavour of the A.B.C. "News Review."

One-third of the replies in the study quoted above referred to the potentially useful ideas or handy hints given in the broadcasts. "Agricultural Digest" each week contains four short items, each designed to convey one or two specific messages. It remains to be seen whether this program will be quoted as a source of information in future evaluations.

The theory of behaviour change — involving a number of identifiable stages, namely: awareness, interest, trial, adoption — indicates that mass media make the greatest contribution at the awareness stage. It is considered that "Agricultural Digest" should merely seek to make rural people aware of techniques and ideas. Frequently listeners are urged to contact their local Departmental adviser, but if interest has been created they will refer their questions to a person able to suggest a solution to their problem. Whether this theoretical aspect has been achieved is not yet known.

The low cost of production of the program is an important feature. Eighty tapes worth £94 are used continuously; equipment is valued at £175; preparation and recording

*Emery, F. E., and Oeser, O. A. (1958)—"Information Decision and Action" (Melbourne University Press, Melbourne).

are done by a graduate and take two hours a week. "Dubbing" and despatching are done by a clerk and take four hours a week. Technical officers preparing an item would on the average spend twenty minutes in preparation and five minutes in recording It can therefore be claimed that the program is a low-cost form of mass media.

Although "Agricultural Digest" appears to meet desired criteria, evaluation in different districts will have to be carried out before any claims are made of its effectiveness.

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Received for publication September 18, 1961.

DEPARTMENT OF AGRICULTURE — VICTORIA

Vacancy for

SOILS OFFICER

Yearly Salary:

£2,153 minimum; £2,293 maximum.

Duties:

To control soil surveying parties in the field, investigate soil problems in the field and laboratory, and to prepare soil maps and soil reports.

Qualifications:

A Degree in Agricultural Science or Science, with considerable experience in soil surveying and soil investigations and in controlling a field staff.

Applications, accompanied by evidence of experience and qualifications and a statement of date and place of birth to be forwarded to the Secretary, Public Service Board, Public Offices, Treasury Place, Melbourne, C.2., by Wednesday the 31st January, 1962.

Thesis Summary

Seed-setting in Subterranean Clover

The investigation was concerned primarily with the effects of environment, particularly the microenvironment of inflorescences and developing seeds, and consisted of three main parts. The first concerned burr burial and artificial protection of individual burrs in a single strain and one environment. In the second, a range of strains varying from early to late maturity were grown in two contrasting environments; These experiments with spaced plants were located at the Institute of Agriculture, University of W.A.; adequate moisture was maintained round the plant roots, and burrs on one half of each plant were prevented from burying themselves. The third part involved a number of strains under sward conditions, with five levels of plant density (and an additional treatment using protective covering of inert material), at two sites in the Western Australian wheatbelt.

The number of inflorescences produced increased with lateness of maturity in spaced plants, but differences among strains were very much reduced under sward conditions. The efficiency of seed-setting (number of seeds per inflorescence) varied among strains and between environments. The breakdown of seed-forming processes occured both before and after the stage at which seed development could be detected visually.

Strains differed in the effect of burr placement on seed-setting, and in general, the beneficial effect of burial was greater in those strains which normally produce a substantial amount of seed below the ground. In a relatively harsh environment, burr burial improved seed-setting in all strains tested. Differences among strains and between environments in number of seeds per inflorescence below ground were relatively small.

The capacity to set seed above the ground varied among strains, and was influenced to a marked degree by environment. In general, there was a negative relationship between the efficiency of seed-setting above ground and the proportion of burrs buried. The amount of plant cover and to some extent its leafiness affected seed-setting above ground, presumably through modification of the microenvironment. This occurred particularly in the early maturing, "stemmy" strains, in which leafiness at maturity increased with plant density. Conditions favouring the production of a greater number of seeds per inflorescence tended also to produce heavier seeds.

Artificial shielding of developing burrs, either individually or *en masse*, had a similar though less marked effect on seed-setting as did natural burial of burrs. Burr burial is apparently a protective mechanism against unfavourable factors (probably low relative humidity and high temperature) of the atmospheric environment.

The extent of burr burial appears to be determined by the interaction between strain, environment and condition of the surface soil. There were marked differences among strains in burial habit, and under normal conditions late-maturing strains set practically all seed above the ground. Burr burial tended to increase in a hot dry environment when soil conditions were satisfactory, and was affected by plant density in some strains.

In brief, the results demonstrate the significance to seed-setting in subterranean clover of the microenvironment of inflorescences and developing seeds, the essentially protective function of burr burial, and wide differences among strains in the degree of burr burial and the efficiency of seed-setting above the ground. The work has been published in *The Australian Journal of Agricultural Research.*

J. J. YATES

Awarded the degree Ph.D. by the University of Western Australia.

Pedology of the Soils in the Merredin Area, Western Australia, with particular Reference to Erosional and Depositional Surfaces and their Effect on Soil Genesis and Distribution

An examination of the Merredin area of Western Australia points to a close correlation between soils and landscape features. The distribution of soils is governed by a system of paired erosional and depositional surfaces which are described in some detail in terms of their vegetation, geology, topography, and soil characteristics.

The area appears to have been effectively insulated from base level changes originating at the coast and only minor erosions, due to changes in landscape stability, have affected the laterised Tertiary surface. For this reason the deeply weathered lateritic profile has had a pronounced influence on both the chemistry and morphology of the soils. Only minor areas of soils formed on relatively unweathered country rock exposed by complete removal of the ancient lateritic profile are present.

Salt lake systems which form the major drainage lines of the area appear to be the remnants of vast river systems formed during the more pluvial Tertiary period. During more arid climates which have succeeded the Tertiary these have become disrupted and now form evaporating basins from which salts crystallised from solution are blown out onto the surrounding countryside. They have further been a source area for an important group of soils formed from aeolian deposits on the lee side of the salt lakes. This material, which has been termed lake parna, has been identified with the parna materials of south eastern Australia.

Multiple depositional layers occurring on both the sides and floors of the valleys show varying degrees of pedological organisation and are evidence of alterations of stable and unstable conditions. These deposits, which differ in their permeabilities, form aquifers which influence water movement from upland areas to the valley floors. The occurrence of excess salinity at various points in the landscape is directly related to these natural aquifers.

Laboratory analyses of selected soil samples are presented both in the body of the text and as appendices.

E. BETTENAY

Awarded the degree M.Sc. (Agric.) by the University of Western Australia.

The Grazing Intake of Sheep and Related Measurements

This thesis has been written in five chapters.

Chapter 1. In this chapter, the literature dealing with qualitative and quantitative estimates of herbage intake is reviewed.

Chapter 2. This chapter describes an experiment in which the herbage intake of ten full-mouthed Corriedale wethers was measured by the faecal-nitrogen technique.

By cutting pasture (Wimmera ryegrass — Subterranean clover) daily, and feeding it to three caged Corriedale wethers under orthodox digestibility trial conditions, regressions were established over 17 weekly periods from October, 1957 to February 1958, for organic matter (O.M.) feed to O.M. faeces ratio on per cent faecal nitrogen (O.M. basis) and for per cent nitrogen in the O.M. intake on per cent faecal nitrogen (O.M. basis). These regressions were then applied to the ten grazing wethers. The following estimates were made on the grazing wethers which were fitted with faecal collection bags: O.M. intake, digestible organic matter (D.O.M.) intake, nitrogen intake, and O.M. digestibility.

The validity of the regressions and the estimates on the grazing sheep is discussed.

Chapter 3. This chapter presents an assessment of the faecal-nitrogen technique for use with irrigated perennial pastures. Two methods of obtaining the regression for O.M. feed to O.M. faeces ratio on per cent faecal nitrogen were used. On the first, the pasture was cut to ground level. This is the conventional method. On the second, two cuts of the pasture were made; a top cut composed mainly of the leaves, and a bottom cut composed mainly of the stems of the pasture. The observations for the conventional regression were made at various times of the year, whereas for the other technique observations were made in the spring and autumn.

It is shown that in fact these regressions, the conventional and the two-cuts, were significantly different. Possible reasons for this and the implication in determining the O.M. intake of an animal grazing such a pasture are discussed.

Chapter 4. This chapter outlines a new approach to the determination of digestibility coefficients.

Basically, the method consists of estimating the slope of the line which relates the cumulative digestible dry matter (or O.M.) with the cumulative dry matter (or O.M.) intake. It is argued that measuring digestibility coeficients by this method has several advantages over the conventional method. The method is demonstrated on observations made on widely different diets.

Chapter 5. This chapter describes an experiment which was undertaken to obtain some basic information on the feeding value of the pods of *Medicago tribuloides*. Physical and chemical properties of the pods were measured together with their digestibility.

J. E. VERCOE

Awarded the degree M.Agr.Sc. by the University of Melbourne.

Some Effects of the Radiant Heat Load on the Merino Sheep with particular Reference to the Insulation Provided by the Fleece

Shorn sheep generally showed a greater rise of rectal temperature during hot (air temperature above 86 deg. F) sunny days, and a greater depression of rectal temperature during the night and early morning than unshorn sheep. The respiration rate of shorn sheep was almost twice that of woolled sheep in the sun about midday. However, wool tip temperatures of unshorn sheep were greater than those of shorn sheep, apparently because of the greater absorptivity of the dark, dirt-impregnated tip.

Rectal temperatures of sheep in poor body condition were more sensitive to changing ambient thermal conditions than those of sheep in good condition; in the midday heat they were higher. That this did not necessarily indicate impairment of the heat dissipating mechanism of these sheep was shown by imposing an added thermal burden through exercise. Rectal temperatures of the poor conditioned sheep then rose to greater values than those of good conditioned sheep, but this rise was matched by a comparable decrease on cessation of exercise. On the analogy that their internal "thermostats" were set at higher levels, this could be advantageous to the sheep by increasing the temperature gradient between the animals and their environment.

Grazing trials indicated that there was no difference between shorn sheep and unshorn sheep in duration or pattern of grazing activity throughout the day. However, all sheep tended

to graze more during the middle of the day on cloudy days than on predominantly sunny days.

The organic matter intake (estimated by the chromic oxide-faecal nitrogen technique) was 15 per cent greater in the shorn sheep than in the unshorn sheep, but this difference was not statistically significant. It is likely that the extra burden borne by the shorn sheep in the experimental environment was of little productive importance, though it could affect grazing, to the detriment of production, in a hotter environment.

Sheep with different lengths of wool were subjected to an artificial radiant heat load estimated as similar to that which they might encounter in the field. To achieve this an infrared radiator was placed at the requisite distance from the back of the sheep to produce a wool tip temperature similar to that found in the field in summer.

There were inverse relationships between wool length and each of the three measurements: rectal temperature, respiration rate and back skin temperature. This shows that the protection available to the sheep against radiant heat depends largely on the length of wool.

Rate of conduction of heat from wool tip to skin was calculated for sheep of different wool lengths. The relationship was asymptotic, the curvature tending to be greatest between wool lengths approximately 1 and 4 cm. Thus at wool lengths less than 1 cm, heat was conducted very rapidly through the wool to the body of the sheep. Above about 4 cm wool length, there was not much additional decrease in conduction of heat through the fleece for each additional centimetre of wool.

Groups of sheep with similar average wool length were compared with and without the radiator at an air temperature of 36 deg. C (97 deg. F). Significantly greater average rectal temperatures, respiration rates and back skin temperatures with radiation showed clearly the importance of this component of the heat load. A similar importance can be presumed for direct solar radiation in the field.

J. T. PARER

Awarded the degree M.Rur.Sc. by the University of New England.

Book Review

The Importance of Nutrition

Health Education Council of W.A., pp. 86

This booklet was compiled by the Council in collaboration with the Department of Public Health, Education Department and Australian Broadcasting Commission. There is no author name, which is a pity, because this booklet is without doubt most valuable, may indeed be unique.

There are two parts: (i) Background information (about 24 pages), and (ii) Topics of the project (about 40 pages)—obviously so chosen because the booklet is intended for use by teachers in the High Schools, as an adjunct to a series of four posters.

Subject matter in part (i) consists of: Energy, food needs, appetite, followed by nutrition in terms of nutrients, with a page or two on beverages, recommended further reading, and recommended daily dietary allowances. Part (ii) deals with (a) Glimpses of nutrition through the ages; (b) Eating for health; (c) Foods for achievement; (d) Foods and energy; (e) Good digestion; (f) Vary your food; (g) Enjoy your food, and a bibliography.

The contents are well presented. In many cases it is honestly admitted that we do not yet know with certainty whether alternative foods are equally nutritious, as in the case of butter and margarine.

Rightly, much is made of the fact that our average intake of calcium and vitamin C is below recommended levels. Emphasis is given to our low and indeed falling consumption of milk, which is reflected in the calcium intake.

Among the many apt examples quoted on special foods one should be mentioned: To obtain 100 calories, such as can be got from 4d. worth of gravy beef, one would need about 6/8 worth of Bovril.

It is to be hoped that the contents of this booklet may become widely known, for it is factual, honest and is plainly stated, and the author is not afraid to admit that "we don't really know—yet", when this is the right term to apply.

A Bibliography of Subterranean Clover together with a Descriptive Introduction

Commonwealth Bureau of Pastures and Field Crops, Mimeographed Publication 1/1961. *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.*2, *Victoria. Price* 15/-.

As Mr. Symon notes in the introduction to his bibliography, "it would not be unreasonable to nominate subterranean clover as the most important agricultural plant in Australia". His bibliography is well timed, coming as it does when the mass of accumulated scientific information on the plant is getting beyond the personal knowledge of the individual worker, yet before it gets so voluminous that a complete compilation could not reasonably be attempted.

The bibliography begins with an introduction, in which certain features of the plant are discussed; this is perhaps the weakest part of the publication, since it falls between two stools, being too long for a guide to the bibliography, but too short to do justice to what is known of the plant. The bibliography itself is in 5 parts. The first is a list of over 1,000 references to scientific papers, arranged alphabetically by authors. The second is a valuable list of some 50 articles in Australian daily newspapers and the agricultural press, covering the period 1900-1924. The third part is a very interesting if possibly incomplete list of 20 pre-Linnean references, and the fourth is a useful cross-index to selected subjects. The fifth part is a supplementary list of 75 scientific papers published in 1959 and up to mid 1960.

By comparison with most other crops, subterranean clover is a new-comer to agriculture, and it is likely that Mr. Symon has succeeded in bringing

together all the scientific papers in which substantial reference to the plant has been made. From these records it is possible to follow not only the history of its use in agriculture, but also the way in which fashions in research work have come and gone during the last 40 years. As would be expected, Australia has been the home of most of the work, but growing interest in other countries, notably North America, is evident.

The publication will be of great interest to all agronomists and others concerned in any way with subterranean clover, but it will, perhaps, be of greatest use to the young research worker faced with the task of finding his way through the formidable body of information now available. For him—and, indeed, for all who are finding difficulty in keeping up with the literature—this compilation will be of inestimable value.

J. N. BLACK

Agricultural Production Functions

by Earl O. Heady and John L. Dillon

Iowa State University Press, Ames, Iowa.

The reviewer's immediate reaction to this book is that the agricultural economist, more especially one primarily interested in farm management, should be grateful for it, whatever its shortcomings might or might not be. Cross-section farm surveys (under certain conditions) provide valuable information not readily obtainable in other ways and production function analysis is one of the appropriate techniques for extracting that information in a usable form. "Agricultural production functions" expounds this technique in considerable detail and should greatly facilitate acceptance of the view that the unanalysed farm survey is not worth doing.

Summarising the contents of this book by chapters:

Chapter 1 is introductory and historical and makes the distinction between biological production functions estimated (usually) from experimental data and farm-firm production functions estimated (usually) from cross-section farm survey data. Both types of function are considered in what follows.

Chapter 2 provides the theory appropriate to the determination of optimum allocation of resources, the production function being known, and this is, of course, largely an exposition of what is found in the economic textbooks as the theory of the firm under pure competition.

Chapter 3 lists various algebraic forms a production function might assume and discusses their properties in the light of the analysis of the previous chapter.

Chapter 4 gives a summary treatment of the theory of statistical regression and of various statistical problems involved in estimating production functions, given the data.

Chapter 5 discusses data collection, the emphasis being heavily on experimental design for the estimation of biological production functions.

Chapter 6 considers the formulation of the economic model, thus determining in detail how the analytical process is to be applied, and the consequences of incorrect formulation.

Chapter 7 deals with miscellaneous questions which do not fit neatly into the framework of the preceding chapters and here the emphasis is on farm-firm production functions.

Chapters 8-17 give an over-detailed account of empirical studies carried out at the Iowa State University.

Thus, although the book is long (667 pages) it is the first 7 of the chapters which are likely to be of most interest and use to the Australian reader.

The organisation of the material and the manner of presentation leave something to be desired. While the formal analytical technique of chapters 2, 3, and 4 is essentially common to the two types of function, the problems and difficulties associated with its application to biological and farm-firm data, respectively, are so very different that one wishes Heady and Dillon had chosen to segregate their material appropriately and to discuss these matters in separate chapters. As it is, the rigidly concurrent organisation of the material means that the reader interested in (say) farm-firm func-

tions will find comment on important matters affecting the application of the technique scattered through a wide range of chapters.

Moreover, the manner of presentation degenerates in places to a mere formal summary (e.g., Chapter 4 on regression analysis and Chapter 5 on designs for the study of response surfaces), and, while this gives a certain dictionary type of completeness to the book, it has the consequence that statistically unsophisticated readers (the majority, one imagines) will have to acquire this vital information elsewhere.

However, these criticisms are essentially minor and there can be no doubt that, for the agricultural economist, this book provides the shortest path to an extensive and accurate understanding of production function analysis.

R. JARDINE

Atlas of Australian Soils — Sheet 1 Port Augusta - Adelaide - Hamilton Area,

by K. H. Northcote

Published by C.S.I.R.O. in association with Melb.University Press, Melbourne, 1960. *Price* 15/-.

Maps showing the distribution of soils over whole continents are usually of little value for practical land-use purposes. Although they are of theoretical interest, and are useful for teaching, the scale of these maps compels an excessive amount of generalisation and an inadequate definition of what each of the mapped units really represents. Northcote has recognised these deficiencies, and has set out to obviate them. He appears to have been reasonably successful, and the series of maps, which will ultimately constitute the Atlas of Australian Soils, seems destined to be of more value than others which have appeared previously.

This particular map, the first of a series of ten, covers the southern part of South Australia, the south-western corner of New South Wales, and the western half of Victoria, on a polyconic projection at a scale of 1: 2,000,000. The 192 basic mapping units, indicated by letter and number symbols, are geographic entities, being easily recognised landscapes or topographic combinations. For each unit, one of 27 colours has been assigned according to the nature of the soil which dominates that particular unit. Consequently, the colour distribution provides a broad picture of the occurrence of the major soils.

Legend No. 1, appearing on the map itself, provides some descriptive information about the morphology of the dominant soils and a key to the particular units in which they are dominant.

Legend No. 2, in the accompanying booklet, provides detailed information not only about the dominant soils, but about other soils occurring in each of the mapping units, and the particular topographic situations within the unit where each might be expected to occur.

The characterisation of the soils and their description has been made according to a scheme devised by Northcote himself, and, in the booklet, the definition of terms and the descriptions of the soils are adequate. A further table relates the soils as characterised by Northcote to the Great Soil Group names previously accorded them by other workers.

In compiling this map, Northcote has accepted and used certain fundamental principles, which have evolved in Australia during the past 20 years. The first of these principles is that, although soils occur in the field in a mixed fashion, their occurrence is not indiscriminate, but according to particular patterns which usually can be rationalised and described. For this reason, units of soil classification are not the best units for mapping, particularly when considering large areas of land. More useful maps are obtained when the units represent groups of soils occurring in characteristic patterns which are described.

In adopting this principle, Northcote has extended the well established Australian technique of mapping soils as groups to provide a unit for mapping of soils on a continental basis. This idea has been

used previously for land surveys, where other features, in addition to soils, are taken into account in the specification of the mapped unit.

The second principle is that for people to understand the map they must obtain a clear picture of any particular soil. Consequently, the soils must be properly defined in unequivocal terms. Northcote achieves this by using his own "Factual Key for the Recognition of Soils," and, although it has led in some places to different colours on the map, where this might not have been expected, it is nevertheless factual, and his precise description can be checked in the field, if necessary.

Some areas separated by Northcote on the basis of "different" dominant soils does not appear to be justified, so far as land use is concerned. This does not mean that Northcote is wrong; it merely indicates that the morphological characterstics he has chosen for separating soils are sometimes not necessarily significant edaphic criteria.

However, in adopting his own key for the recognition and definition of the soils, Northcote has infused some reality into broadscale soil mapping. The accurate descriptions provide real information which can be interpreted as the user might choose.

This is a map which the casual user might easily misinterpret, but the intelligent user who is prepared to read and understand the information provided, will find it of real assistance.. The accuracy, or inaccuracy of the boundaries, and the descriptions of the units given in Legend 2 will only be assessed after a period of continued use, but even at this stage they appear to be accurate.

In the area covered by Sheet 1, Northcote was able to use a large amount of available soil survey information, but it will be interesting to see whether be can maintain this standard in some of of the subsequent sheets where less information is available, and, consequently, where more field traversing will be required.

It is doubtful whether the map will be of great value to those concerned with land-use, whose needs can only be satisfied by more detailed maps indicating the nature of all features of the landscape, and not just the soils. However, unlike some other maps of the soils of large areas, which are admired but not used, this map should provide a handy reference, and, without doubt, will provide people with a much clearer picture of the nature and distribution of our soils.

R. G. DOWNES

The Principles and Practise of Farm Management Accounting

by C. A. Mallyon

Obtainable from the Law Book Co. of A'sia Pty Ltd., Sydney, Melbourne and Brisbane. Price £3/3/-.

Mallyon has divided his book into seven parts, with the subject matter broadly covering four main aspects of his proposals for farm management accounting.

One might expect that it could be no more than a general statement of the main role of the rural accountant in assembling financial data for farm management analysis and advisory work. In effect, however, as suggested by the title, and as the book develops, it is obvious that it is intended to be far more embracing. It is through this that it loses much of its value.

One of its purposes is "showing the primary producer what he could expect from his accounts and how they will assist him in making profitable decisions". The amount of detail given, however, is excessive for readers at the farm level. Another of its aims is "providing a blue-print for accountants, agricultural economists (and) extension workers . . .", but here again the book does not fulfil its role. Students will find it lacking as a text, whilst experienced workers would generally be in advance of the elementary details given in many sections, particularly the earlier ones dealing with the installation and operation of the accounting system.

Mallyon states that the book "being a pioneer in this country in the broader field of farm management accounting, in all probability will not entirely

fill its destiny". He adds, however, that "if it but leads to better things in the future it will have played its part".

There will generally be no argument that the accountant, as well as the agricultural economist and the agricultural scientist, has important contributions to make in the development of techniques for farm management. Each could, therefore, aim at "better things" by assembling data in the most readily adaptable form for use in important management decisions. Where the accountant is concerned, this could be the use of more streamlined methods which are known to exist.

Chapter 23 provides a blue-print for reporting to the farmer subsequent to a complete analysis of the year's operations. Besides being a rather lengthy document supported by ten separate schedules and Statements of Account, it casts the accountant in the role of farm management adviser. There are as many dangers in this approach as there would be, for example, in advisers of basically agricultural training, attempting complicated, family financial arrangements and settlements, requiring a high degree of knowledge in such matters as taxation, probate, gift duty and accountancy generally.

In the third section, Mallyon moves to a discussion of budgeting; its newer refinement, linear programming; and a consideration of the possibilities of project accounting. The latter he defines as the limited application in rural industry of cost accounting procedures used in secondary industry. Here, one great difficulty, if not an impossibility, is the proper allocation of expenses among complementary farm projects. For example, to what extent does the superphosphate used on last year's crop influence this year's wool production; to what extent do livestock influence crop results? How should one allocate expenses incurred in operating multi-purpose machinery for which a direct method of allocation is impossible? Mallyon suggests several remedies according to circumstances and the nature of the costs involved. Some of these are the adoption of standard costs, allocation of repair and maintenance costs according to tractor hours employed on separate projects, and finally, where no other solution exists, transferring to general expenses for allocation in proportion to the gross income from separate projects. The immediate impressions gained are that the amount of work involved can at best lead to a general assessment only of the real position regarding all costs, and that, despite attempts to justify the work involved in developing project accounts, they remain a rather optimistic statement with little basis in fact.

The final section discusses forms of ownership under the separate headings of sole proprietors, partnerships, companies and trusts; giving the various benefits attaching to each system. The book concludes with a review of the future of farm management accounting in relation to Farm Management Clubs, the accountancy profession, farm management laboratories and market forecasting.

As indicated at the outset, this book attempts a very wide coverage and one must doubt whether it will become a standard text in its present form.

L. J. DURHAM

Talks | Symposia

Better Research Through Better Extension

On July 21, 1961, the Northern Sub-Branch of the New South Wales Branch held a symposium with the title "Better Research Through Better Extension." The talks and subsequent discussion are summarised here.

The speakers were:—

Mr. T. J. Croft, grazier and former president of the Northern N.S.W. Sub-Branch;

Mr. A. Nelson, Director of the Department of Adult Education, University of New England;

Mr. H. Parry Brown, Chief, Division of Information Services, N.S.W. Department of Agriculture.

Dr. Joan Tully, of C.S.I.R.O., at present seconded to the Department of Adult Education, University of New England, for work on community development projects.

Professor J. N. Lewis, Dean of the Faculty of Agricultural Economics, University of New England.

Mr. T. J. Croft. Many of the problems which appear to be subjects for research to the graziers actually are problems of extension. The extension services are satisfactory for small problems but not for the more complex ones such as care of ewes and lambs. In considering this problem Mr. Croft had had to refer to at least five different research publications instead of being able to get a summary of the results from the extension service. He suggested that the N.S.W. Agricultural Gazette, which was not held in high regard in the farming community, be replaced by regional publications which would give review summaries of research results.

Mr. Croft then referred to the problems of the extension officer. His suggestions were:

(a) Extension officers should have twelve months devoted to training in methods of farm management analysis and in extension methods. They should spend several years at research stations and several more years as assistant district agronomists before being considered fully qualified for their job.

(b) Extension officers should be free of all administrative and clerical duties.

(c) They should not be moved frequently between the regions of the Department of Agriculture's extension organisation. Different conditions and industries greatly reduced their effectiveness if this were done.

(d) Extension officers should be free to go to conferences so that they would be better equipped for their job and find more interest in it.

One reason for the Conference was to discuss the question of allocation of industry funds between extension and research. Mr. Croft suggested that these funds should be allocated mainly to research, but that some of them would be well employed in the co-ordination of extension work.

Mr. Nelson spoke on the topic, "The University's Part in Rural Extension."

Those who are responsible for extension must be aware of the social and technological changes that are taking place at such a rapid rate, and they must be able to offer extension programs which meet the challenges that these changes bring. Two points are basic: The first is that education to be effective must be continuous with life, and the second is that rural extension must be the responsibility of many agencies.

One of the aims of adult education must be to expand the small group in which education is an active process throughout life. This group has an influence in the community out of all proportion to its size. On the land the people who lead the way with improved practices come from this group.

The need for many agencies arises from the variety of educational requirements which exist in a rural or any other community if life is to be varied, and the capacities of the individual are well developed. With technological change and the increasing complexity of farm problems the extension worker must be drawn increasingly into the field of education for management. The industrial and commercial manager wants to continue to make his own decisions, but he looks to management education to help him sharpen his wits and refine his judgment; to answer the question "Why?", rather than "How?", and to get the facts on which to base his decisions. Many farm managers of today seem to feel the need for this kind of help. They do not want to be told what to do, but they do want the kind of help which will enable them to make their own decisions more confidently and competently.

The specific points where the University should enter extension are:

(a) With courses in adult education at a University standard and courses where university workers present their findings. The role of the University in providing correspondence courses in adult education for

those people who are out of touch with other institutions, is particularly important.

(b) Experimental work in rural extension. Because of its comparatively flexible approach the University is in a strong position to undertake experimental pilot projects.

(c) The study and teaching of extension as a field of knowledge. For this purpose an Institute of Extension should be set up to undertake research and teaching in the field of extension.

(d) Work with other organisations. The University should have a role in helping other organisations to build worthwhile programs of adult education and to develop skills in the field of adult education.

(e) Post-graduate and refresher courses for extension and research workers.

(f) Community development programs. The aims of these are briefly, to help communities to see themselves as whole communities, to help them to define and appreciate their developmental problems, and to advise them or put them in touch with appropriate advice on the action they might take.

Mr. Nelson then referred to the current program of the Department of Adult Education which involves residential schools, short-term local conferences, community development projects and weekly courses. Some 8,000 people participated in this program in 1960.

Mr. H. Parry Brown, speaking on "the ideal extension worker", said the ideal would vary with the community served.

There are communities wherein the front-line agricultural extension worker needs to be very much a generalist; communities where broad farming knowledge and experience make him acceptable. This is his horizontal plane of personal competency. It is basic to his vertical plane of personal competency, viz. a specialist capacity for developing in his community a favourable regard for extension service and other agencies. He of course needs nearness to subject-matter specialists for consultations.

A glance around the world prompts a thought that in such communities major changes in farming and methods are in any case the product of agencies other than this type of extension worker—agencies of national expenditure programs that divert vast sums into inducement, rehabilitation, and reconstruction programs.

On the other hand are the many communities with which we are more familiar, wherein the agricultural extension worker has sufficiently progressive clients to make it essential that he have a technical subject-matter specialty or vertical plane of technical competency, as well as a general competency in respect of the farm-enterprises typical of his area, i.e. a horizontal plane of technical competency. Without the vertical plane of technical competency he might not hold the regard of leader-farmers in his area. Without the horizontal plane of technical competency he could not relate his vertical competency to the farm as a whole.

Mr. Brown suggested the latter as the "ideal" for New South Wales; e.g. an agronomist in a wheat and sheep district and a sheep and wool officer serving the same district should have general competency in respect of farm-enterprise in that area, but, needing advice on livestock aspects, the client or community would lean to the sheep and wool officer, or needing advice on non-livestock aspects the leaning would be to the agronomist. Similarly, a dairy farmer who has pigs would lean towards a specialist piggery officer for advice on pigs and lean to a dairy officer for advice on dairy cattle husbandry or to an agronomist for advice on non-livestock matters, though the piggery officer, the dairy officer, the agronomist should each have a general competency in respect of dairy-farm enterprise as a whole in that area.

The ideal extension worker would appreciate the need to keep abreast of changing information, and of his continuing need to discard old ideas as well as to learn. If he were not susceptible to change, how could be expect in farmer clients a favourable attitude to change?

He would appreciate, too, his place in a two-way flow of information — from the research worker and the farmer to the extension worker, from the extension worker to the farmer and the research worker; his role in helping individuals and communities to recognise and define their needs; his role in helping research or administrative bodies to establish priorities for attention to problems requiring their help before the defined local needs may be answered.

He would have the skills and equipment of an adult educator; would know the relative values of the mass, group and individual media of contact in traversing the behaviour-steps of a client or community whose attention has to be gained, interest won, motivation assured, before farmer trial and evaluation — leading, *perhaps,* to general adoption of a new or different way of doing something — could be expected.

He would have a working appreciation of psychology, a capacity to recognise and respond to individual differences, to assure acceptance of himself as a friend rather than as an official, and a capacity to motivate.

He would have a working appreciation of sociology, would be aware of factors affecting rates of diffusion and adoption and practice of new information within the community. To counter his disappointment with those rates he would acknowledge the strength of a factor described as "social consequence of technological change". He would, in this respect, appreciate that, to most families on the land, farming, though increasingly a business, is still a way of life; that changes in the way of doing things on the farm often are seen there as changes in way of life, the cost or consequence counted by farm people just as are monetary costs and returns.

The ideal front-line extension worker would also devote a special measure of his time to one or two pilot properties, strategically selected and located, for farm development programming and management supervision. In the ideal, he would seek and have the interested support of community opinion in giving a special share of his time to this service to selected properties. Success of this service, even to so limited a number of properties, would help the evolution of farmer-clubs as employers of advisers to specialise in such service.

To improve extension effectiveness, the most constructive approach would be increased farm development programming and management supervision. To assure requisite intimacy of knowledge of each farm whole, this type of adviser would preferably confine his attention to a numerically small clientele. The implied increase in advisory personnel is so great that this evolutionary peak of extension service may only be attained if farmers themselves reach for and finance it through promotion of corporate groups, as employers.

Relating this to the symposium topic, it would be logical to suggest industry diversion of some of the industry funds to help establish pilot groups or to subsidise pilot groups to employ farm programming and management supervisors.

These subject-matter specialists, employees of farm groups, would of course maintain close liaison with subject-matter specialists of official extension services, for advice on matters outside their own vertical specialisation in farm development programs and management supervision.

Dr. Joan Tully. There is need for a new discipline of extension education which would integrate other disciplines (in particular those of education, psychology, social psychology, and sociology), and focus their attention on problems of extension in the same way that agricultural science has integrated and used the disciplines of chemistry, botany, physics, etc. This discipline should provide post-graduate training in extension analogous to the Diploma of Education in the teaching profession.

Research has shown that the three main methods of extension, mass communication, individual contact, and group work, benefited the same group, comprising approximately 25 per cent of the farm population. Thus they are not the solution of the problem of educating a higher proportion of farmers.

Dr. Tully's suggested solution is to use the multiplying effect which occurs from discussion if extension is given in the framework of small neighborhood communities which are permanent face to face groups. In contrast, field days, residential schools, and public meetings only form temporary groups and do not lead to motivation for learning and change through the forces of group dynamics.

Dr. Tully then suggested two propositions related to this extension within communities.

A. Attitudes can be changed and action promoted if members of a community can, as a community, be induced to recognise their problems and the possibility of solutions. This provides motivation for change and mutual support for change.

B. The more central the problems recognised are to the interests, needs, values, and goals of the community the more effective will be the frame of references set up in changing attitudes and providing motivation for change.

Professor J. N. Lewis. The balanced allocation of resources between research and extension and the kinds of research and extension programs to be undertaken depend pricipally on the nature of agricultural problems; at the present time the most pressing problems of agriculture in Australia are essentially economic in nature.

In part these problems derive their nature from:

A. the growth of capital requirements for farming;

B. the increasing complexity of management decisions;

C. the fact that off-farm problems are looming larger; the decline in Australian farm incomes is occurring because of the growth in agricultural output, rather than in spite of it.

As a result of these trends we need more emphasis on farm management research and extension, and more attention to marketing, to closer integration of production and market requirements, and to problems of agricultural policy.

The economic approach must be woven thoroughly into the fabric of the extension services and not merely superimposed upon existing work. Agricultural economists should not allow themselves to be

misused by being cast in the role of clerks, entrusted only with checking that all new practices developed are economic and suitable for recommendation as "approved practices." Although this is a common image of agricultural economics, it is based on misunderstanding and, moreover, reflects a distorted view of the agricultural extension process.

Amongst the more obvious weaknesses of extension services in Australia are:

A. the pay and status of the job are too low;

B. extension workers enjoy little or no opportunity for advanced study after graduation because of the absence of study leave provisions and because in-service training facilities are limited;

C. the need for development of the specialist study of extension, at University level.

An Institute of Extension established at the University of New England would help the profession of agricultural extension gain a position in the community more commensurate with its national importance.

As the natural place in which this development should be centred, the University of New England offers a conjuncture of favourable conditions not duplicated or even approached elsewhere in Australia. Apart from its unique location in a rural environment, its existing facilities and established interests in the fields of Adult Education, Rural Science, Agricultural Economics and Sociology, make it eminently suitable as a workshop for research on extension.

Present and Future Importance of the Meat Industry to Australia

Summary of address by Mr. J. L. Shute, Chairman, Australian Meat Board, to the A.C.T. Branch, July 6, 1961.

Australia's plans for satisfactory marketing of export meat could be seriously affected by political action in countries at present taking substantial quantities of our meat and even the best conceived plans could be affected in this way.

We have experienced the effect of changing financial and fiscal policies, and in recent times have actively and successfully resisted efforts to restrict the entry of our meat to important markets.

We naturally view Great Britain's possible entry into the Common Market with concern. The Australian meat industry could benefit or could suffer as a result, depending on the conditions of such entry.

In recent years, meat has played an increasingly important role in Australia's economy. In 1959-60 it ranked second only to wool in Australia's export earnings, and has been well to the fore for many years.

The United Kingdom has, in the past, been the traditional market for the bulk of Australian export meat, but this position has changed materially in recent years. Since the second half of 1958, there has been spectacular development of markets in North America for boneless meat, both beef and mutton, and tonnages of beef and mutton shipped to North America have exceeded those sent to the United Kingdom. Useful quantities of lamb have also been shipped to North America.

Japan shows promise of developing as a market for the cheaper grades of meat, and during the last two years would have taken much more manufacturing mutton and beef, if prices in the United States had not been high enough to absorb the bulk of the supplies available. Other Asian markets could become important outlets for Australian meat in the foreseeable future, particularly if living standards there continue to improve.

It is impossible to forecast accurately, even a short time ahead, the future for meat, as so many factors influence market demands. However, soundly-based expansion of beef production in Australia can be undertaken with confidence. Lamb presents difficulties, and it would seem that for the present, at least, increased production should be related to the demand for lamb in Australia. Mutton has virtually become a by-product of the wool industry. Increasing demands for manufacturing quality mutton suggest that this class of meat could continue to find a ready market, and thereby supplement wool earnings.

There are a number of features which seem to justify sound expansion of meat production in Australia. These include:—

1. The Australian market takes an average of about four-fifths of our production, leaving only about one-fifth for which satisfactory export markets have to be found.

2. Australia can produce meat as cheaply as, if not more cheaply than, most other exporting countries.

3. Despite seasonal hazards, the Australian environment for meat production is more favourable than that of many other countries, and our stock are free from many serious diseases prevalent in other countries.

4. Australian leaders are becoming more aware of the importance of the livestock industries to the future of the Commonwealth, and it is reasonable to assume that they will support policies designed to assist in the sound development of these industries.

A well-organised and well-informed meat industry, capable of quickly sizing up changing trends and preparing to meet them on a co-ordinated basis, is one of he greatest assets the meat producer needs to guard his interests.

Technical Progress - its Benefits to Consumer and Farmer

Summary of address by Mr. F. H. Gruen, of Australian National University, to the A.C.T. Branch, August 3, 1961.

Technical advances in agriculture are likely, in the long run, to benefit consumers rather than producers of many products. Technical change can present an agricultural industry with economic problems in some instances. There are usually two effects of innovations:

(1) The expansion effect, when, thanks to the technical advance, production and investment in the industry becomes more profitable.

(2) Following this, the expansion in output often causes a fall in price for the product, and encourages a move away from this industry to other forms of production.

As an example of the economic effects of technical change in agriculture, myxomatosis more or less wiped out the rabbit population in the early fifties when rabbits were a major obstacle to increased wool production, and expensive and laborious counter-measures were necessary just to keep their numbers stationary. It was estimated that destruction of rabbits boosted wool production by 70 million lb, or an estimated 6 per cent, in 1952-53.

In following years, the decline in rabbit populations probably allowed some further increases in sheep numbers, leading to increased wool production as a result of myxomatosis. Apart from this effect, wool production became more profitable, since rabbit-control expenses disappeared — that is, a number of investment possibilities, such as pasture improvement, extra watering facilities in low-rainfall areas, clearing, fodder conservation, and so on, became more profitable. In other words, myxomatosis provided an indirect incentive to increase wool production and to direct investable funds to wool production. This could be called an expansion effect of an innovation.

It was not possible to separate this added incentive from other factors responsible for increased wool production, such as favourable wool prices in the fifties, and so on, but it seemed likely that myxomatosis played an important part, not only directly, but more probably indirectly, in the 50 per cent increase in Australian wool production over the following decade — a rate of increase unequalled since the 1890's.

The second part of the adjustment process was that, partly because of rival fibres but also partly because of the great expansion in the Australian wool clip, wool prices had been falling in recent years — the second effect of an innovation. An increase in the relative output of a product of the innovating industry sets in motion a decline in price. This leads to what might be called the substitution effect — producers move out of wool production to fat lambs, wheat, dairying, beef, and sometimes out of rural industry entirely.

What are the net effects of the process of innovation? The price of the product of the innovating industry declines. In other words, a large proportion of the benefit of technical progress is passed on to consumers.

The net effects of technical progress on the incomes of producers depend on the elasticity of demand for the product in question. If there is not much room for expanded production, particularly in a short time, producers of a product are likely to get lower incomes after technical change than before. Demand varies of course, but generally speaking, the demand for broad groups of goods such as food and clothing is likely to be less elastic than for individual products, because in the broader group there is more possibility of substitution between the individual products.

Speaking broadly, the shorter the time interval under consideration, the lower the elasticity; and the richer people become, the lower the elasticity of demand for farm products is likely to be. This means that farmers as a whole stand to lose as a result of technical progress in agriculture, although society as consumers stand to gain somewhat more than the actual increase in productivity resulting from the particular innovation.

However, individual farmers — the early adopters of the innovation — would of course gain. Further, while farmers as a whole might lose, the farmers in an individual country which sold on world markets

would probably gain, unless tariff or transport barriers offset the advantage brought about by the technical advance.

A further aspect is that technical progress in one form of farm production might benefit all producers in this field but react against rival products, e.g., the expansion of the broiler industry probably benefited poultry farmers, but probably partly at the expense of producers of other meat products like beef, lamb, or pork.

Technical advances might favour one section of an industry at the expense of another. On a local scale, for instance, pasture improvement and various other techniques raised productivity in the winter rainfall areas without any corresponding improvement in the summer rainfall areas. As a result, dairy farmers in the summer rainfall areas suffered from the lower prices caused by the expansion of output in the more-favoured districts. In this case the economic problem came from too little technical progress in the less-favoured areas.

The same sort of thing happened on a world basis where producers were in competition with farmers from other countries. Generally speaking, Australian producers of farm products which have an export market are likely to gain rather than lose from rapid technological progress. However, once again a general improvement in all countries concerned is likely to lead to surpluses where the market cannot take much more of the product.

There is no doubt that technical progress leads to great benefits for society as a whole. In fact, a number of economic studies have shown that most of the gains in our living standards over the years can be largely attributed to this factor, interpreted in its widest sense. Nor have farmers, at least in the past, failed to benefit from technical progress.

Technical progress occasionally imposes income reductions and capital losses on some groups when productivity gains are particularly rapid in one sector of the economy or when it is much more rapid in one geographical sector of an industry than in another. These income and capital losses occur because, generally speaking, we benefit more from technical progress in other industries than from technical progress in the industries in which we happen to be engaged.

Economics and the Farmer

A symposium entitled "Economics and the Farmer", organised by the Tasmanian Branch and held in Hobart on 3rd August, was attended by 180 people, including Department of Agriculture personnel, representatives of banking and commercial interests, and a large number of primary producers from all parts of the State.

The Branch President, Mr. D. Berry, opened the proceedings and briefly outlined the reasons for the choice of subject. It was thought that the discussions would benefit both agricultural scientists and farmers, and would probably provide useful leads for future investigations in the economic analysis of agricultural problems. Mr. Berry welcomed the Federal President, Mr. C. S. Christian, who acted as chairman.

Mr. R. H. Thomas, a primary producer of "Northdown", Latrobe, gave his very comprehensive views on the farmer's need for economic guidance. Among the points upon which Mr. Thomas felt guidance was needed were the choice of property; its optimum size for efficiency; and the quantity, source, and terms of borrowed capital. In planning his use of the property, the farmer needed guidance on such matters as budgeting, capital repayment, and the principles to be followed in making the choice between using farm plant, labour, and transport for particular purposes, or hiring the services of contractors and carriers.

Mr. Thomas then discussed a number of other points upon which guidance would be welcomed, such as the economics of added expenditure to reduce maintenance costs, the best form of ownership of property, and the economic effects of tariffs and subsidies, taxation, and monetary controls.

Mr. G. M. Percival, Principal Research Officer of the Commodities Section, Bureau of Agricultural Economics, Canberra, followed with a review of the present position and prospects of the major primary export industries, including dairy products, wool, lamb, and apples. Of particular interest were his comments on the possible consequences of Britain's joining the European Common Market.

Mr. D. J. Fergusson, Agricultural Economist, Department of Agriculture, Tasmania, in speaking on the subject of Economic Aspects of Changing Farm Production, pointed out that the marginal pound spent in any form of farm production should be able to earn as much as it would in any alternative form of production, but expressed the view that preoccupation in the chase after the last ounce of return from one enterprise often meant that others, begging for exploitation, were not seen. He gave a number of examples of alternative uses of resources, in the form of labour and capital, to increase overall farm efficiency, but pointed out that the farmer's

abilities, aims, and desires played a big part in determining which of the alternatives were appropriate in given circumstances.

Mr. G. Webster, a Director of A. G. Webster and Woolgrowers Limited, Hobart, gave a lively account of his researches into the financing of rural industry in Tasmania. His conclusion was that the total capital represented in improved land, crops, stock and machinery in rural industries (including orchards, small fruits and hops) in Tasmania is £116,000,000, of which £93,500,000 is the invested capital of the farmers, £15,000,000 is on mortgage and about £6,000,000 is owed to the Trading Banks and Wool Houses. After examining the possible sources of finance for the purchase of agricultural land, Mr. Webster concluded that no more money was likely to be available from them. Mr. Webster then pointed out that many of the holders of land represented in the £93,500,000 invested capital wished to realise, probate had to be met on many estates, and unless some new source of cheap finance became available to assist would-be purchasers and inheritors bearing a heavy probate burden, the price of rural land must diminish rapidly.

Mr. W. A. Beattie, Agricultural Consultant, Croydon, Victoria, spoke on budgets and their application. Outlining the form a farm budget should take, Mr. Beattie dealt with the many factors which could affect its accuracy, and the uses and benefits which should follow its compilation. He stressed, however, that the mere making of a budget was only an essential preliminary and it was only the action based on the budget that brought economic benefit to the farmer. He pointed out that the budget leads inevitably to work study, a form of efficiency stimulus well known in industry, and gave examples of this process in operation.

In concluding, Mr. Beattie dealt briefly with the concept of linear planning, pointing out that it was essentially of short-term application in agriculture where the validity of assumptions on prices and costs could quickly be upset by seasonal fluctuations and market conditions. An important conclusion was that land use is largely determined by the aptitude and preference of the farmer for a particular type of farming, and that if he excels in that type of farming he is not likely to make more money in another occupation even though it may theoretically be more remunerative.

After a lengthy discussion, the chairman summed up the day's proceedings and pointed out the need to aim at efficiency of production, not only on the individual farm, but also on a regional, state, and national basis. He emphasised the dependence of the economist and the farmer on the agricultural scientist, who must provide the underlying technical basis upon which sound planning of farming operations and sound economic advice must rest.

The Wheat Industry in Australia

Summary of address by Mr. T. C. Stott, M.P., General Secretary of the Australian Wheatgrowers' Federation to the A.C.T. Branch, September 7, 1961.

The 80,000 members of the Wheat Federation were very appreciative of the work of the Institute. Today because of the necessity for economic considerations there must be a very close liaison between the scientist in the laboratory and the farmer in the field.

The Wheat Research Council and the respective State Research Committees had already performed very valuable service to the Wheat Industry from the contribution made by the industry and from the Government's matching contribution. However, some of the work is being held up because there is insufficient trained personnel with the necessary technical knowledge to undertake the projects planned ahead.

Mr. Stott emphasised —

1. The wheat industry would continue to be prosperous if the Guaranteed Wheat Price Stabilisation Plan was continued and if U.K.'s entry into the Common Market did not disrupt world trade in wheat.

2. The International Wheat Council should take further steps to adjust world wheat trade through the International Wheat Agreement made necessary by the Common Market and should control surplus disposal programs by quotas multilaterally. Undeveloped countries needing wheat should have the necessary currency made available for purchases through the World Monetary Bank.

3. The Commonwealth Government would be forced through the effect of the Common Market to follow the trend of all world governments today by providing a guaranteed price to wheat producers for all wheat exported overseas. Our overseas commitments and the importance of our trade balances will fully justify and warrant this incentive to Australian wheatgrowers.

Mr. Stott pointed out that during the past five years the ratio of income to costs proved that costs were overtaking the net income of wheatgrowers. He said there was a big potential for increased acreage sown to wheat particularly in Queensland. The extent depended upon the seasonal conditions and prices for other coarse grains and for wool.

He forecast an increase in the cost of production of wheat due to the recent 12/- per week increase in the basic wage.

Tillage Research in Europe and the U.S.A.

Summary of an address by Dr. Greacen to the South Australian Branch.

The National Institute of Agricultural Research, Silsoe near London, formed in 1927, was moved to its present site, Wrest Park, in 1947.

The staff, an agricultural engineering group, consists of 360 workers of whom about 100 are technical officers. One group of workers studying the effect of passing a tillage implement through soil, have developed special equipment for measuring the components of draft. From this they have equated shear strength with cohesion (soil-soil and soil-metal friction) and the work done in lifting the displaced soil. Present work is aimed at altering the cohesion factor, one method being based on the finding that minimum draft is dependent on a critical angle of attack, or rake, of the tillage implement. This parallels work in Melbourne which showed that there was a critical method of sharpening disc ploughs to reduce draft.

Another group at Wrest Park is examining soil structure in relation to plant requirements and work is proceeding on projects whereby oxygen tension is altered in bins with different water table levels and the growth of plants observed; diffusion of gas down the soil profile is examined with radioactive krypton which is quite inert in soil, and soil nitrogen and water requirements are studied with bacterial culture growth.

At Gröningen, in Holland, bin studies of difficult soils are being carried out using wetting agents and repellents in attempts to make the soils manageable. The big obstacle in these bin studies is to overcome the loosening of soils when placed in the bins. This often prevents the field effects on soil from compaction and tillage from being reproduced for study. A further development at this centre is the use of soil solution Ca++ concentration measurements as an index for liming of clay soils.

Thirteen elaborately equipped agricultural institutes have been developed by Allied funds in 600 acres of forest at Braunschweigen, near the East German border. This area previously housed a very advanced, secret wartime aeronautical research institute.

In the soil cultivation institute, electronic technicians take measurements of practically everything done. One group there is studying wheel effects on soil, factors being studied include: traction versus percentage slip, penetration and shear as the wheel moves forward, effect of wheels and ploughs on ploughsole development (by means of a two layer plough), reductions in draft achieved by tractor-mounted implements, and effects of clodiness in tilth. Other fields of study include reduction in draft at speed by ploughshape modification using cinephotography tracings of thin pencils of light reflected off ploughshares set at various angles; cultivation treatments of a clay and a loess-type soil in bins and the effect on plants under controlled moisture conditions; effects of cultivation on soil temperature for seedling emergence; and soil moisture loss measurements using ceramic plate evaporimeters set one metre below cylinders of soils. This latter development was also seen at Copenhagen.

In the U.S.A., studies are just beginning at Alabama on the shatter and drop effects of tillage. At Cornell, plough-plant studies have been carried out for four years; so far soil erosion losses from plough-planting direct into stubble or sod have been less than conventional seed-bed cultivation methods. By altering the sign and amount of charge on ploughshares, drying or wetting of the immediately surrounding soil has been achieved to alter the soil-metal friction factor in studies there.

Work is also proceeding on plant growth and compaction studies in the U.S.A., but Californian work is taking up to six years to give results.

This difficulty of obtaining the desired or expected responses in plant growth is the main reason why most research is at present aimed at reducing draft in the treatment of a given volume of soil, rather than improving tillage methods for better plant growth.

News Items

William Cottrell-Dormer

Mr. Cottrell-Dormer arrived in Australia in 1914.

He was employed as Assistant to the Entomologist with the Queensland Bureau of Experiment Stations from 1921-26, and in that time studied the sugar cane beetle and carried out the first survey of sugar cane diseases in Queensland.

After graduating M.Sc.Agr. from Brisbane University in 1931 he returned to the Bureau of Sugar Experiment Stations as Assistant Plant Pathologist and until 1934 carried out research work on bacterial diseases of sugar cane, including etiology of Red Stripe Disease and development of single cell culture methods for study of bacterial strains.

From 1934-39 he was with Fairymead Sugar Co. Ltd. as Research Officer and worked on sugar crystallisation and juice clarification; Mitscherlich and other soil testing methods; and in the British Solomon Islands in Association with Lever Bros. Ltd., on the *Amblypelta* Nutfall Bug of coconuts.

From 1939 to 1944 he was Director of Agriculture for the Tongan Government and was responsible for introduction of the *Agricultural Organisation Act* 1940 creation and establishment of the Tonga Copra Board and other instruments for the orderly marketing of primary produce. During portion of this period he was also Acting Government Secretary and was responsible for the transfer of the old Government College from Nukualofa to a prepared site in the country and for the introduction of a strong agricultural bias into the College Curriculum.

In 1944 he returned to the Queensland Department of Agriculture in Brisbane as Horticulturist and worked on pollination in tomatoes and on varietal testing in this and other vegetable crops. During this period he developed an electrically operated tomato pollen collector which is now universally used in tomato and cyclamen genetic research.

From 1946 to 1951 was Director of Agriculture for Papua and New Guinea, and was responsible for the organisation and establishment of the post-war Department of Agriculture, Stock and Fisheries with special insistence on the creation and maintenance of a Division of Agricultural Extension separate from the Research Divisions. To facilitate certain aspects of extension amongst the native people, he introduced a simple form of Co-operative known as the Rural Progress Society.

In 1951 Mr. Cottrell-Dormer resigned from Directorship and became Senior Field Officer in the Extension Division in order to work in closer contact with the native people. Since that time he has concerned himself principally with the problem of the exchange of ideas between the people and the Government Officers. With this aim, he has been responsible for the introduction and establishment of a rural organisation based on Village Agricultural Committees, Village Women's Committees and Agricultural Associations, in Eastern Papua. The system has greatly facilitated agricultural extension work in the area and accelerated native advancement. It has also led to considerably improved liaison and co-operation in the area between Government Departments concerned with the advancement of the village people.

Institute's Annual Meeting 1962

The Annual General Meeting will be held in Canberra next year, probably March 19-21, 1962. This will inaugurate the new policy of rotating the meeting round the capital cities.

A.C.T. Branch has already started preparing for the event. It is proposed to hold a full-day seminar on the general subject of science in agricultural production, with specialist speakers on animal sciences, plant sciences, economics, etc.

Russian UNESCO Fellow

Professor V. F. Chervinsky, of the Council on the U.S.S.R. Productive Forces Research, Academy of Sciences, Moscow, is visiting Australia at the present time as a UNESCO Fellow. He spent some time with the Division of Land Research and Regional Survey before leaving Canberra to visit Queensland, the Northern Territory, and Western New South Wales.

Professor Chervinsky is studying pasture and livestock management in the arid zones of Australia, and is comparing the desert conditions prevailing in Australia with those east of the Caspian Sea in his own country.

Range Management in U.S.A. and Australia

Mr. R. A. Perry, of C.S.I.R.O. Division of Land Research and Regional Survey, has just returned to Canberra after 12 months' study leave in U.S.A. His subject was range management, which he studied for two semesters under Professor R. Humphrey at University of Arizona, Tucson. He then spent three months inspecting ranges in the Western States.

Mr. Perry said that range management, which would be called pasture management in Australia, is the science and art of obtaining maximum livestock production fom range land consistent with conservation of the land resources. This subject developed in U.S.A. because of the large areas of range damaged by over-grazing and erosion, and a great deal of attention has been given to repair of this misused land. This is a costly process, usually involving heavy government contributions.

In Australia we are fortunate that we do not have very large areas of over-grazed land, due to a lower stage of development in our pastoral industry. We should therefore guard against such serious situations as developed in U.S.A., which might come here as development progresses.

A feature of the U.S.A. scene is the number of organisations concerned with range management. The Forest Service, the Agricultural Research Service, and the Soil Conservation Service, all branches of U.S.A. Department of Agriculture, have specialists in range management in their respective spheres of activity, while Bureau of Land Management and Bureau of Indian Affairs of Department of Interior also have specialists. In fact, one of the studies one makes in this field is the study of the organisations themselves and their relation to range management.

Federal President Visits India and Rome

During September *Mr. C. S. Christian,* Federal President, visited India at the request of the Indian Government to give further advice on development of the Indian Central Arid Zone Research Institute at Jodhpur. Mr. Christian was responsible for planning this Institute in 1958 at the request of UNESCO and the Indian Government. He also had discussions with recently-appointed research staff at the Institute.

During his recent visit he toured various parts of Rajasthan and inspected field work and advised on future progress. Field visits included an inspection of the Kjed area where nomadic pastoral tribes are being settled.

Whilst at Jodhpur he was asked to inaugurate the Indian Association for arid zone research workers.

Mr. Christian also visited New Delhi where he discussed with officers of the Department of Agriculture future requirements of the Arid Zone Research Institute.

At the request of UNESCO he then went on to Rome for discussions on arid zone research matters, and to attend the UNESCO-WMO Symposium on Climatic Change.

Blue Mould Epidemic in Europe

Mr. A. V. Hill, of C.S.I.R.O. Division of Plant Industry, Canberra, visited Greece during July-August at the urgent request of the Greek Government to advise on control of Blue Mould in tobacco. This disease has spread from west to east and south across Europe in the past two years, and was first noticed in Greece in late spring, 1961.

After visiting the tobacco areas — which are scattered all over Greece — and conferring with officers there, Mr. Hill then went at the request of the European Tobacco Research Organisation to a meeting on Blue Mould at the French Tobacco Institute at Bergerac.

Many other European countries have, as a result of these visits, requested Mr. Hill to return to advise them on the control of Blue Mould. Arrangements are now being made for him to spend 6-7 months in Europe from February, 1962.

These invitations are an indication of the high standing of Australian work on Blue Mould control in tobacco.

Victorian Department Changes

Mr. W. B. Miller is now Deputy Director of the Victorian Department of Agriculture following the appointment of Mr. F. M. Read as Director. Mr. Miller was previously Superintendent of Agriculture. This position has now been filled by Mr. W. J. B. McDonald.

Mr. H. L. Hore takes over from Mr. McDonald as Senior Inspector of Agriculture.

These three men have contributed a great deal to the development of a wide range of crops in Victoria. Mr. Miller and Mr. Hore have been principally interested in cereals, while Mr. McDonald's main interests have been tobacco, flax, linseed, and potatoes.

Report on Dairying in South Gippsland

The Farm Survey Research Branch of the Victorian Department of Agriculture has published a report of its survey of dairy and pig farms in the Woorayl Shire of South Gippsland.

The report describes the economic position and the farm management practices of the farms and also includes a section dealing with the pig enterprise.

The analysis was then carried further, with regression analysis being used to discover which farm management practices affect production and net income. The marginal concepts of economic theory were applied to the results of this analysis to determine levels of income obtainable when these practices were used.

Standards of performance have also been laid down for farms in this area. The study also indicates lines of research which are likely to prove fruitful in the investigation of the problems of this important dairying area.

CITRUS

Total area planted to citrus fruits in Australia is now approaching 60,000 acres, of which some 47,000 acres are bearing. This is an increase of about 15 per cent on pre-war plantings. New South Wales is the largest citrus growing State, with about half the total Australian acreage.

Overall average production is about 160 bushels per acre, although growers in South Australia have achieved averages exceeding 260 bushels per acre. Of the various types of citrus fruits grown, oranges comprise more than 80 per cent, and it is chiefly in this form that the average Australian eats about 38 lb citrus each year.

Throughout Australia's citrus growing areas, nitrogen fertilisers are of prime importance. Citrus trees require nitrogen in much greater amounts than other nutrients and applications of 6 to 8 cwt. per acre of sulphate of ammonia are often made.

For optimum yields and high quality fruit, the correct balance between nutrients must be maintained. The nitrogen-phosphorous balance is particularly important in some areas and also the relative availability of magnesium, potassium and calcium. Increasing use is being made of leaf-analysis techniques to assist growers with applications of nitrogen and phosphorous but, whatever the grower's particular needs, the Australian fertiliser industry is well equipped to supply his requirements.

Inserted by Nitrogen Fertilisers Pty. Ltd., 500 Bourke Street, Melbourne, C.1.

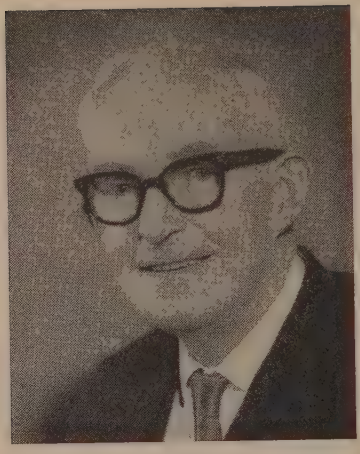
Fellows of the Australian Institute of Agricultural Science 1961

The class of Fellows of the Australian Institute of Agricultural Science was created to honour members who have made an outstanding contribution to the profession, or to agriculture in general.

Mr. G. H. Burvill; Superintendent, Plant Research Division, Department of Agriculture, Western Australia

Professor C. M. Donald; Professor of Agriculture, University of Adelaide

Mr. R. G. Downes; Chairman, Soil Conservation Authority, Victoria



Mr. P. G. Ryan; formerly Director of Agriculture, Victoria

Mr. A. L. Tisdall; Commissioner, State Rivers and Water Supply Commission, Victoria

Personal Notes

Australian Capital Territory

Mr. W. Hartley, Plant Introduction Officer, Canberra, who has been a member of C.S.I.R.O. Division of Plant Industry for over 30 years, left for Washington in October for three years as Chief Scientific Liaison Officer.

Mr. E. S. Hoffman is attending the Eleventh Session of F.A.O. at Rome as a member of the Australian delegation under the leadership of Mr. J. V. Moroney, Secretary of the Department of Primary Industry, Canberra.

New South Wales

Mr. E. O. Tout has retired from the position of Under-Secretary and Permanent Head of the New South Wales Department of Agriculture. He had been with the New South Wales Public Service for 49 years, had been Under-Secretary since 1959 and Assistant Under-Secretary for the previous 16 years.

Mr. G. Edgar has been appointed to replace Mr. E. O. Tout as Director-General of Agriculture and Permanent Head of the Department. Mr. Edgar joined the Department in 1926 and was engaged in research into livestock diseases. He was Director of Veterinary research before his appointment as Assistant Under-Secretary in 1959. In July of this year, Mr. Edgar was appointed a member of the Faculty of Veterinary Science, University of Sydney.

Mr. E. S. Clayton has retired from the position of Commissioner of the Soil Conservation Service. He joined the New South Wales Department of Agriculture in 1915 as an Experimentalist on Experiment Farms. Following work on soil erosion he was sent to United States in 1936, and in 1938 he was appointed head of the Soil Conservation Service of New South Wales which was formed at that time.

Mr. L. G. Kaleski has been appointed as the Commissioner of the Soil Conservation Service, replacing Mr. E. S. Clayon. Mr. Kaleski joined the New South Wales Department of Agriculture as an agrostologist in 1936 before joining the Soil Conservation Service in 1939. He was Senior Research Officer from 1945 to 1949 prior to his appointment as Chief Soil Conservationist, the position which he held until his appointment as Commissioner.

Mr. H. R. Richardson has resigned as Principal of Hawkesbury Agricultural College, a position which he has held for seven years. He joined the Department of Agriculture in 1937 as a Plant Breeder, and was Deputy Principal of the College from 1948 to 1954. At the end of this year he will enter commerce.

Mr. B. Doman is to succeed Mr. H. R. Richardson as Principal of Hawkesbury Agricultural College. Mr. Doman is at present Principal of Wagga Agricultural College, a position he has held for nearly 13 years. He joined the Department of Agriculture as a trainee in 1928, and was appointed as Assistant Plant Breeder in 1932, and lecturer at Hawkesbury Agricultural College in 1937.

Queensland

Recent staff changes in the Department of Agriculture and Stock are:

Dr. R. W. Downes has been transferred from Brisbane to Parada where he will be engaged in plant breeding programs aimed at improvement of pasture and fodder crops.

Mr. R. C. Cannon, formerly Senior Horticulturist (Plantation Crops), Nambour, has been appointed Assistant Director of Horticulture, Brisbane.

Dr. A. W. S. May, formerly Senior Entomologist, Toowoomba, has been appointed Assistant to Director, Division of Plant Industry, Brisbane.

Mr. K. M. Ward, formerly Senior Horticulturist, Brisbane, has been appointed Chief Horticulturist stationed at Redlands Experiment Station.

Mr. E. Weston has been transferred to Toorak Station to develop a program of pasture research in North-West Queensland.

Mr. P. Kerridge, formerly a Research Assistant in Agrostology, Department of Agriculture, University of Queensland, left Australia recently for Bogor, Indonesia, where he will spend two years under the Volunteer Graduates' Scheme whereby Australian graduates take up employment with the Indonesian Government.

New appointment to C.S.I.R.O.'s Division of Tropical Pastures is *Mr. R. Roe,* Principal Research Officer, who has been transferred from the Division of Plant Industry, Armidale. He will work in the field of pasture ecology.

Dr. J. Griffith Davies, Chief of C.S.I.R.O. Division of Tropical Pastures, was an official Australian Delegate to the 10th Pacific Science Congress in Hawaii where he presented two papers on pasture establishment and management.

South Australia

Congratulations of branch members go to *Professor C. M. Donald* on being elected a Fellow of the Australian Institute of Agricultural Science at the 180th Council Meeting of the A.I.A.S. held in August.

Dr. A. D. Rovira, Research Officer, Soils Division, C.S.I.R.O., and *Mr. J. V. Jacobsen,* Horticultural Research Officer, Deparment of Agriculture, were recently awarded Fulbright travelling scholarships.

Messrs. *A. J. Nicolson* and *D. E. Elliott,* Soil Conservation Officers, Department of Agriculture, Adelaide, took up country appointments in September. Mr. Nicolson is stationed at Nuriootpa, and Mr. Elliott at Cleve.

Mr. C. B. Wells, Soils Division, C.S.I.R.O., returned to Adelaide in September after two years' study leave overseas on a Sir George Murray Scholarship. He has been based at Rothamsted for most of this period; one of the highlights of his stay was a three-weeks' Soils Congress tour which included visits to fourteen European capital cities.

Mr. N. S. Tiver, Chief Agricultural Adviser, S.A. Department of Agriculture, returned from overseas late in August. While overseas he presented a paper at the Eighth International Grassland Congress at Reading, England; studied land reclamation in the U.K. and Europe; and spent nine months studying irrigation of pastures and fodder crops at Davis, California, as part of a 12-months' Harkness Fellowship in the U.S.

Dr. R. N. McCulloch, formerly Principal, Roseworthy Agricultural College, left in September to take up an appointment with the N.S.W. Department of Agriculture, to direct a new research station in northern N.S.W., established to investigate cattle tick control and quarantine.

S.A. branch members who attended the Conference of Cereal and Pasture Plant Breeders at Canberra in the first week of August included *Professor C. M. Donald, Dr. K. Finlay* and *Messrs. P. McK. Barrow, M. R. Krause* and *E. D. Higgs.*

Mr. T. C. Miller, Chief Horticulturist, S.A. Department of Agriculture, returned to Adelaide in October after acting as Assistant Fruit Officer in the U.K. in the Commonwealth Department of Primary Industry for the 1961 export season. Mr. Miller spent most of the time in London and during the last month visited the U.S.A.

Dr. L. H. May, Plant Physiology Department, Waite Institute, returned in October from overseas study leave. Dr. May spent several months at Nottingham and visited Europe and the U.S.A.

Mr. K. P. Barley, Agronomy Department, Waite Institute, returned to Adelaide in October after 12-months' study leave in the U.S.A. and Europe, which included an 8-months' temporary appointment at the Department of Soils and Plant Nutrition at the University of California, Berkely.

Victoria

Mr. C. E. Cole, Superintendent of Horticulture of the Victorian Department of Agriculture, returned to Australia on October 20 after a five months' tour of horticultural centres in England and America.

Mr. G. H. Vasey, Reader in Agricultural Engineering at Melbourne University, represented Australia at an international conference on tractor testing in Turin, Italy, in September. Before attending the meeting, Mr. Vasey was able to visit several European tractor testing and research stations.

Dr. R. H. Watson is continuing his work in the field of physiology of sheep at the Department of Agriculture's Animal Husbandry Research Centre at Werribee. Dr. Watson was formerly at the C.S.I.R.O. Animal Health Laboratory at Parkville.

Two members of the Victorian Branch of the Institute attended the Eleventh Conference of Agricultural Economists held in Mexico in August. *Mr. L. E. Cozens* of the Department of Agriculture stayed over on his way to Cornell University, and *Mr. A. G. Lloyd* of the University School of Agriculture was away for the second term vacation.

Mr. P. Baxter, horticultural research officer with the Department of Agriculture, returned to Melbourne

early in September after ten months' study at the University of Bonn, West Germany, under a Humboldt Fellowship. He continued his research into the nutrition of fruit trees, especially the role of calcium in the development of the apple disorder "bitter pit".

Mr. M. G. Hawson has joined the Department of Agriculture in Western Australia and will work at Carnarvon. He was with I.C.I. in Melbourne, and was on the committee of the Victorian branch.

Mr. R. Carne is now working as an agronomist in the Department of Agriculture after fourteen years in New Guinea.

Mr. R. B. McMillan, Director of the Australian Wool Bureau's Statistical Service, has been appointed Acting Chief Executive Officer of the Bureau. He has been Director of the Bureau's Wool Statistical Service since its inception in 1954. Before that he was head of the wool section of the Commonwealth Bureau of Agricultural Economics.

Western Australia

Three West Australians have recently returned from overseas.

Dr. T. C. Dunne, Director of Agriculture, was the Australian delegate to the recent F.A.O. conference in Rome.

Mr. N. Halse, of the Department's Plant Research Division, spent several months in the United States studying the American tobacco industry. It is hoped that the results of his visit will help the Australian tobacco growers to produce leaf more acceptable to the manufacturers.

Mr. W. J. Toms, also of the Plant Research Division, made a flying visit to the United States to study American cotton growing techniques. He is now stationed in the Kimberleys, where he will be associated with the growing of the first commercial cotton in the Ord River Scheme.

Mr. I. Stott has left the Sheep and Wool Branch of the Department of Agriculture to take up an appointment with the Commonwealth Development Bank. His appointment was one of several recently made by the bank, which is increasing its agricultural staff in Western Australia.

Branch Notes

Australian Capital Territory

A.C.T. Branch Committee

President, C. W. Strutt
Vice President, T. T. Colquhoun
Secretary, J. R. McWilliam
Treasurer, B. D. H. Latter
Assistant Secretary, B. B. Brett
Sub Editor, D. V. Walters
Committee A. F. Gurnett-Smith
R. O. Slatyer
W. D. Hardy
Immediate past President, O. H. Frankel.

Queensland

The August meeting of the Branch was replaced by a function designed to strengthen ties between Agricultural Science and the farming community and its associated organisations. The function was held on the Monday of Show Week, August 14, and over 200 members and guests attended. The program commenced with a conducted tour of the University of Queensland, after which guests gathered for cocktails and a buffet dinner. The evening concluded with an address by the Federal President, Mr. C. S. Christian, who, under the title "This Agricultural Science," discussed contributions made by agricultural science.

The September meeting was held at the Cunningham Laboratory, St. Lucia, on September 25. The address, "Automatic computors and agriculture," by Professor J. M. Bennett, Professor of Electronic Computing in the University of Sydney, continued a series of talks discussing progress in agricultural science and its importance to agriculture.

The next of the series was given on October 25, also at Cunningham Laboratory. Professor H. J. G. Hines, of the Biochemistry Department of the University of Queensland, spoke on "Recent advances in biochemistry and their significance in agriculture."

Northern Victoria Sub-Branch

At the third annual general meeting of the sub-branch held earlier this year at Benalla, Mr. I. S. McMillan of Dookie College was elected president and Messrs. Gartrell and Beviss joint secretary-treasurers. The chief business item was a move to prepare for a symposium in 1962 on some phase of pasture work. Associate-Professor G. W. Leeper addressed the meeting on "The Slow Progress of Soil Science".

The second meeting was held in Wangaratta in June. A sub-committee was elected to do the spade-work of the pasture symposium, those elected being — Messrs. R. Gartrell, D. F. Smith, M. Martin, J. Avery and I. Cameron. Dr. Morley of C.S.I.R.O., Canberra, gave a stimulating and challenging address on "Utilization of Pastures".

On October 6 the third meeting was held, this being the first at Shepparton since the formation of the Sub-Branch. Guest of Honour was Mr. A. L. Tisdall of Melbourne. A progress report was given on the pasture symposium, and it was decided to defer attempts to hold a combined Northern Victoria-Southern New South Wales meeting till next year. Mr. Tisdall reviewed some of the major problems of irrigated agriculture and handled the many questions with competence and discretion.

South Australia

At a meeting held on September 1, Mr. J. H. Harding, Research and Investigation Officer, South Australian Woods and Forests Department, gave a particularly informative illustrated address on "Aspects of Forestry in South Australia."

Dr. E. L. Greacen, Senior Research Officer, Soils Division, C.S.I.R.O., Adelaide, who recently returned from an overseas study tour, addressed members at a meeting held on September 29. Dr. Greacen spoke on "Tillage Research in Europe and the U.S." and showed a number of slides illustrating facilities, equipment, etc., and tourist features of his trip.

On October 12, the S.A. branch held all-day Symposium in the Burnside Town Hall. Over 200 people, representing farmers, industry, research and extension workers, and fields allied to agriculture, attended this Symposium which had the theme, "Water for Agriculture."

The morning session, chaired by the 1961 S.A. President, Dr. K. W. Finlay, Reader in Plant Breeding, Waite Agricultural Research Institute, was devoted to "Improvement in Water Supply." Dr. E. G. Bowen, Chief, Division of Radiophysics, C.S.I.R.O., Sydney, presented a paper on "The problems of rainfall, prospects for rain-making and for long-range forecasting." This was followed by a paper on "The conversion of saline water; methods, costs and prospects," presented by Dr. H. R. C. Pratt, Officer-in-Charge, Section of Chemical Engineering, C.S.I.R.O., Melbourne. The final morning paper on "The water resources of South Australia, problems of surface water supply and future prospects," was given by Mr. J. R. Dridan, Engineer in Chief, Engineering and Water Supply Department, Adelaide.

The afternoon session, chaired by Mr. A. J. K. Walker, Chief of the Division of Plant Industry, S.A. Department of Agriculture, dealt with "Improvement in water use." Mr. J. W. Holmes, Senior Research Officer, Division of Soils, C.S.I.R.O., Adelaide, gave a paper on "Soils, land surface, and the efficiency of water use". Then followed a paper by Mr. P. Judd, Irrigation Research Officer, S.A. Department of Agriculture, on "Better crops and better use of irrigation water". The last paper on "The economic distribution of irrigation water" was given by Mr. R. Culver, Senior Lecturer in Civil Engineering, University of Adelaide.

Following the vote of thanks by Professor R. N. Robertson, Professor of Botany, University of Adelaide, an informal Sherry Party brought the proceedings to a close.

Western Australia

A feature of recent meetings of the W.A. Branch has been a series of regional talks, given by members who are experts on the various agricultural regions of Western Australia. The series began with a talk by Mr. K. Fitzgerald on agriculture in the Ord River scheme. This was followed by talks on the dairy industry in the South-west by Mr. S. Dilkes and Mr. F. Ryan, both members of the Dairying Division of the W.A. Department of Agriculture. The third meeting in the series was on the Esperance Region, when talks were given by Mr. F. L. Shier and Mr. E. N. Fitzpatrick, both of whom have been closely associated with development at Esperance. This series was completed in November with talks on the North-west pastoral regions. It was a well-planned and

successful series, all talks being topical and based on considerable agricultural experience and research by the speakers.

A departure from this year's regional theme was the October meeting, which was devoted to a discussion of agricultural extension and inspired in part by the recent A.I.A.S. Extension Committee report. The subject was introduced by the Branch President, Professor E. J. Underwood, who reviewed the report and its reception by Council and the other branches.

A talk was then given by Mr. T. E. McDowell, Agricultural Adviser in the Narrogin disrict. The main points of Mr. McDowell's address were:

1. Do those in authority recognise any need to change extension in Australia? If not, few changes are likely to follow the A.I.A.S. Extension Committee report or any other report.

2. What is the function and policy of each body involved in extension? Full and frank discussion between the various authorities would do much to clarify the situation.

3. Publicity about weaknesses in agricultural extension in the present confused situation only reacts unfavourably on the extension worker.

4. It is apparent that more studies are needed in this field of communication.

Farm Management Clubs

Discussion has been continuing with the Federation of Farm Management Advisory Services concerning the failure of the various clubs to appoint graduates to advisory positions, and much of the initial misunderstanding has been cleared up. The Federation has said that graduates would have been appointed had suitable men applied, and that farm management experience was desirable but not essential and was not the prime requirement. Graduates would always be appointed where suitable men were available.

The Federation believes that farm club positions have now become highly attractive to the extension worker with the right approach to this sort of position. Salaries and conditions are good, and so are the opportunities to do valuable work, but these must be weighed against the obvious disadvantages of this type of position. Personality of the individual is of prime importance.

While graduates are as scarce as they are at present, there is little more to be done about this situation. The Federation has expressed its interest in any scheme which will increase the supply of graduates.

From the Institute's point of view the claim by some members who answered a questionnaire sent to extension workers that the professional standing of these positions had been down-graded by appointment of diplomates as advisers is considered by some members as the most serious objection raised.

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Obituary

R. P. ROBERTS

Agricultural scientists in Western Australia were shocked by the sudden death of Mr. R. P. Roberts on August 26 this year. Mr. Roberts, who was officer-in-charge of the Department of Agriculture's Rural Economics and Marketing Section, was 55.

He was one of the best known and most widely respected agricultural scientists in Western Australia, and a key man in the Department of Agriculture. His colleagues for many years had relied on his sound judgment and knowledge of agriculture in Western Australia, and his frankly critical but always sound and helpful suggestions helped to solve many a difficult problem.

Mr. Roberts graduated from the University of W.A. in 1928 and completed his M.Sc.(Agric.) degree in 1934. He spent some years as an adviser, mainly in country districts, before specialising in economics.

Among his many valuable activities in several fields was a long record of service to the Australian Institute of Agricultural Science. He was a leading member of the W.A. Branch from its inception in 1934, and was Branch secretary for many years as well as president for 1941.

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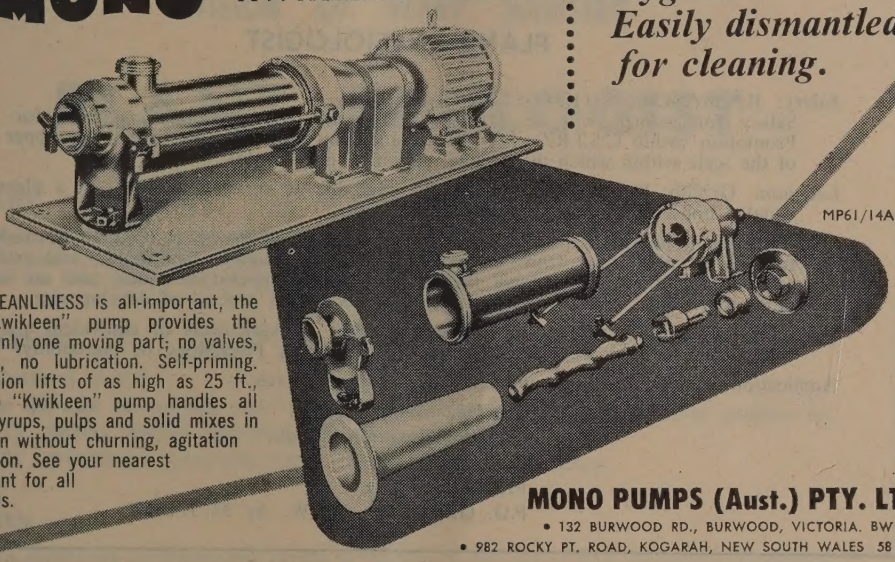

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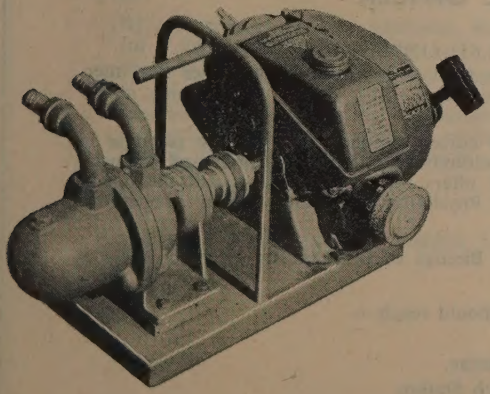

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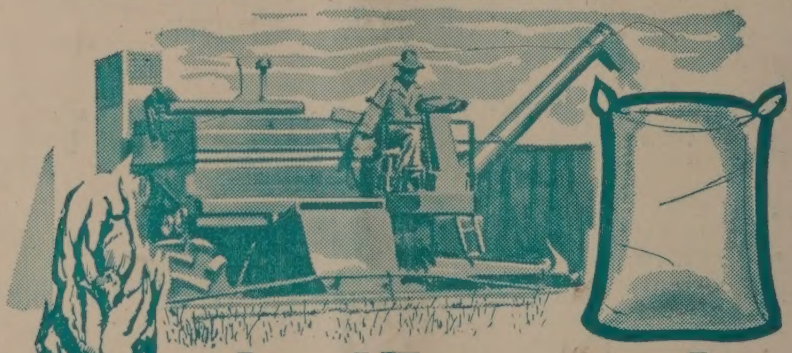

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